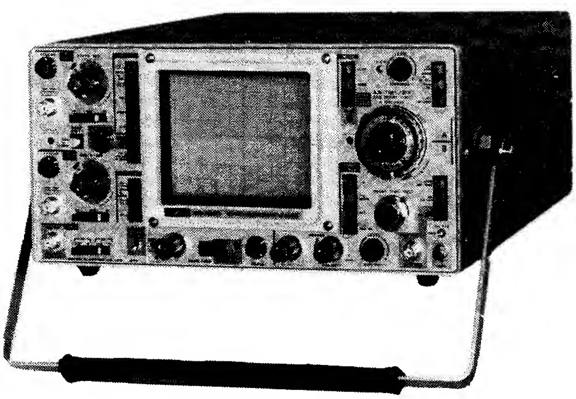
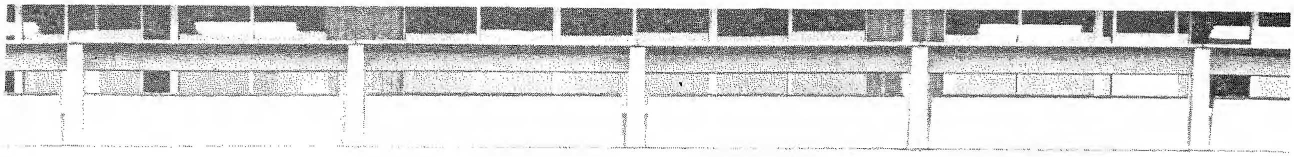


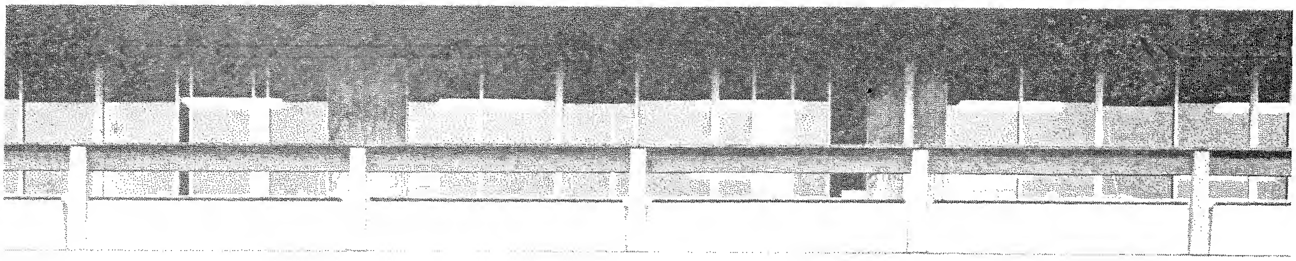
INSTRUCTION MANUAL

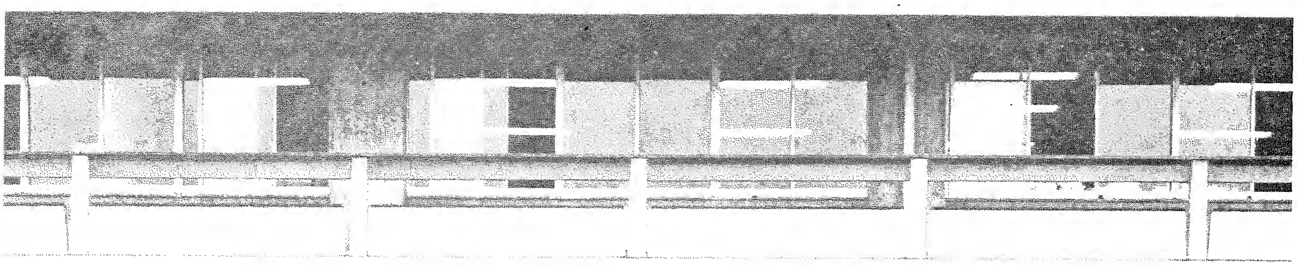
OSCILLOSCOPE

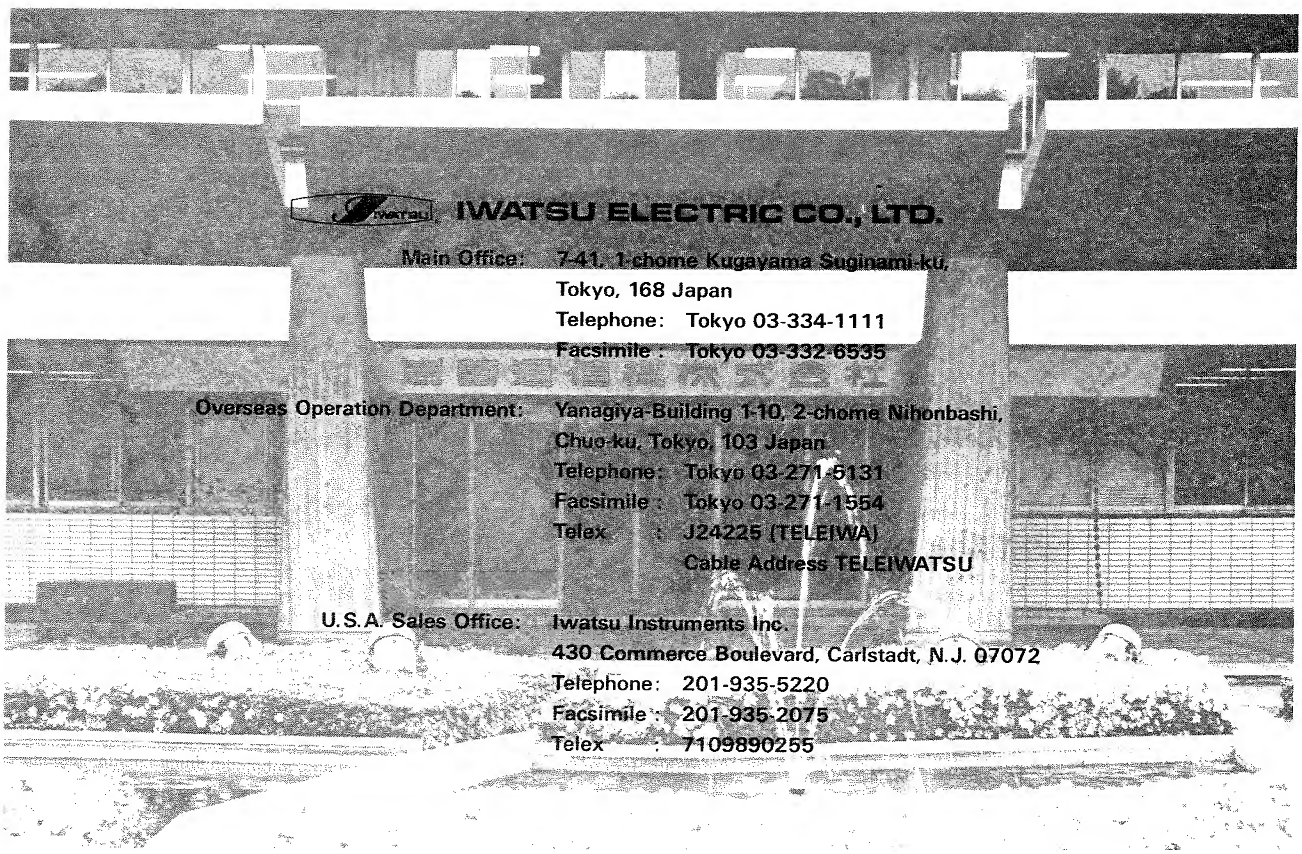
SS-5321

L4419-813101(L)









IWATSU ELECTRIC CO., LTD.

Main Office: 7-41, 1-chome Kugayama Suginami-ku,
Tokyo, 168 Japan
Telephone: Tokyo 03-334-1111
Facsimile : Tokyo 03-332-6535

Overseas Operation Department: Yanagiya-Building 1-10, 2-chome Nihonbashi,
Chuo-ku, Tokyo, 103 Japan
Telephone: Tokyo 03-271-5131
Facsimile : Tokyo 03-271-1554
Telex : J24225 (TELEIWA)
Cable Address TELEIWATSU

U.S.A. Sales Office: Iwatsu Instruments Inc.
430 Commerce Boulevard, Carlstadt, N.J. 07072
Telephone: 201-935-5220
Facsimile : 201-935-2075
Telex : 7109890255

General

The SS-5321 is a high quality oscilloscope of portable type which covers a frequency bandwidth on DC up to 250 MHz.

The vertical deflection system allows measurement of sum of two signals (ADD) or difference between two signals (with CH2 POLAR switch), as well as ordinary dual-trace or triple-trace measurement (ALT and CHOP). The Channel 1 and Channel 2 are designed for the high sensitivity which reaches 5 mV/div and the sensitivity can be increased up to 1 mV/div by connecting the two channels in cascade. Signal applied to the Channel 3 can be also used as the external trigger signal for Channel 1 and/or Channel 2 and displayed on the CRT.

The horizontal deflection system can be triggered with signals on DC up to 250 MHz. The trigger (sweep) mode suited for measuring objective can be selected from AUTO and NORM. As the sweep rate is provided to 1 ns/div, high speed phenomena can be measured accurately. Functions such as sweep magnification, delay sweep, alternate sweep, holdoff control, single sweep and X-Y operation are provided.

The cathode-ray tube is a square type incorporated with parallax free internal graticule. The effective viewing area is 8 divisions (vertical) by 10 divisions (horizontal) in size and high intensity observation is possible by high accerelation voltage of 20 kV. Furthermore, the trace intensity can be enhanced in high speed sweeps.

The internal circuitry is designed as a full solid-state structure. Furthermore outstanding stability and reliability of operation is ensured by wide use of integrated circuits.

CONTENTS

SECTION 1
SPECIFICATION

Cathode-Ray Tube (CRT)

CRT Type	Rectangular
Graticule	8 div X 10 div (1 div =10mm), Internal graticule, Variable edge lighting.
Phosphor	P31 (standard), P11 (option)
Accelerating Potential	Approximately 20kV.
Brightness Enhancing	Brightness can be enhanced in sweep range from 10 ns/div to 0.5 µs/div.
Beam Finder	Returns trace to graticule area.

Vertical Deflection System

Display Modes: Channel 1, Channel 2, Alternate display of Channel 1 and Channel 2, Chopped display of Channel 1 and Channel 2 (chopped repetition rate : 1 MHz ±40%), Added display of Channel 1 and Channel 2, Alternate or chopped display of Channel 1, Channel 2 and Channel 3.

Channel 1 and Channel 2

Deflection Factor: 5 mV/div to 5 V/div in 10 calibrated steps in a 1-2-5 sequence.
5 mV/div to 12.5 V/div continuously variable with control.
Accuracy: ±2% (10°C to 35°C)
±5%(−10°C to 50°C)

Frequency Response: (10°C to 35°C)
5 mV/div:
DC to 200 MHz −3 dB
10 to 50 mV/div :
DC to 250 MHz −3 dB
0.1 to 0.5 V/div:
DC to 250 MHz −3.1 dB
1 to 5 V/div:
DC to 250 MHz −3.5 dB
Notes:
1. The AC-coupled lower −3 dB frequency is 4 Hz or less (0.4 Hz or less with X10 probe).
2. The bandwidth with the BANDWIDTH switch pushed-in is approximately 20 MHz.

Rise Time: Approximately 1.4ns (250 MHz bandwidth).

Pulse Response: Overshoot: 5% or less
Sag: 1% or less
Other distortion: 4% or less (at 10mV/div)

Delay Line: Allows viewing of leading edge.

Input Coupling: AC, GND, DC

Input RC: Direct: 1MΩ ±2%//16pF ±2pF
With X10 probe: 10MΩ ±2% //13pF ± 2pF

Maximum Input Voltage
Direct: 500V (DC + Peak AC)
With X10 probe: 600V (DC + Peak AC)

Common-Mode Rejection Ratio
50:1 or greater at 1 kHz
15:1 or greater at 20 MHz

Drift: 0.2 div/hour (typical) after a 30-minute warm-up.

Polarity Inversion: Provided for Channel 2.

Cascaded Operation: (Channel 1 signal output connected to Channel 2 input)

Deflection Factor: 1 mV/div

Accuracy: ±4% (10°C to 35°C)
±8% (−10°C to 50°C)

Frequency Response DC to 20 MHz −3 dB

Channel 3

Deflection Factor 0.1 V/div, 1 V/div
Accuracy: ±3%(10°C to 35°C)
±8%(−10°C to 50°C)

Frequency Response (10°C to 35°C)
0.1 V/div: DC to 200 MHz −3 dB
1 V/div: DC to 200 MHz −3.5 dB

Notes:

1. The AC-coupled lower −3 dB frequency is 4 Hz or less (0.4 Hz or less with X10 probe).
2. The bandwidth with the BANDWIDTH switch pushed-in is approximately 20 MHz.

Pulse Response Overshoot: 7% or less
Sag: 2% or less
Other distortion: 5.5% or less (at 0.1 V/div)

Input Coupling AC, DC

Input RC Direct: 1MΩ ±2%// 16pF ±2pF
With X10 probe: 10MΩ ±2% //11pF ±1.1pF

Maximum Input Voltage
Direct: 500V (DC + Peak AC)
With X10 probe: 600V (DC + Peak AC)

Triggering

Internal Trigger Source
Channel 1, Channel 2, Channel 3, Normal (displayed signals)

A Triggering

Source Internal, Line

Coupling AC, HF REJ, DC

Slope Positive-going, Negative-going

Sensitivity Shown in Table 1-1.

Table 1-1 (10°C to 35°C)

Frequency range	Channel 1 and Channel 2	Channel 3
DC to 10 MHz	0.3 div	0.2 div
10 to 100 MHz	1.0 div	1.0 div
100 to 250 MHz	1.5 div	1.5 div

Notes:

1. Signals below 30 Hz are attenuated in the AC coupling.
2. Signals above 10 kHz are attenuated in the HF REJ coupling.
3. In the AUTO position of the sweep MODE switch, the lower end of triggerable frequency is 50 Hz.

B Triggering

Source Internal, External

Coupling AC, DC

Slope Positive-going, Negative-going

Input RC 1 MΩ ±5% // 20 pF ±5 pF

Maximum Input Voltage
500 V (DC + Peak AC)

Sensitivity Shown in Table 1-2

Table 1-2 (10°C to 35°C)

Frequency range	Internal	External
DC to 10 MHz	0.4 div	75 mVp-p
10 to 100 MHz	1.0 div	150 mVp-p

Note: Signals below 30 Hz are attenuated in the AC coupling.

Horizontal Deflection System

Display Mode A sweep, A intensified by B, Alternate sweep of A and B, B sweep

A Sweep

Sweep Mode	Automatic, Normal, Single
Sweep Rate	10 ns/div to 0.5 s/div in 24 calibrated steps in a 1-2-5 sequence. 10 ns/div to 1.25 s/div continuously variable. Accuracy I (over center 8 divisions): ±2% (10°C to 35°C) ±4% (−10°C to 50°C) Accuracy II (over any 2 divisions within center 8 divisions): ±5% (10°C to 35°C)
Holdoff Time	Continuously variable with the HOLDOFF control.

B Sweep

Sweep Mode	Automatic, Triggered
Sweep Rate	10 ns/div to 50 ms/div in 21 calibrated steps in a 1-2-5 sequence. Accuracy I (over center 8 divisions): ±2% (10°C to 35°C) ±4% (−10°C to 50°C) Accuracy II (over any 2 divisions within center 8 divisions): ±5% (10°C to 35°C)
Delay Time	1μs to 5s Accuracy: ±3% (10°C to 35°C)
Delay Jitter	1/20,000 or less

Sweep Magnification	10 times (Maximum sweep rate: 1 ns/div) Magnified sweep rate accuracy I (over center 8 divisons, 10°C to 35°C): 0.1 μs/div to 50 ms/div: ±3% 10 ns/div to 50 ns/div:±4% 1 ns/div to 5 ns/div: 5% Magnified sweep rate accuracy II (over any 2 divisions within center 8 divisions, 10°C to 35°C): 0.1 μs/div to 50 ms/div: ±5% 10 ns/div to 50 ns/div: ±6% 1 ns/div to 5 ns/div: ±10%

X–Y Operation

Input	X: Channel 1, Y: Channel 2

X-Axis

Deflection Factor	Same as Channel 1. Accuracy: ±3% (10°C to 35°C) ±5% (−10°C to 50°C)
Frequency Response	DC to 2 MHz −3 dB
Input RC	Same as Channel 1.
Maximum Input Voltage	Same as Channel 1.

Y-Axis	Same as Channel 2.
X-Y Phase Difference	3° or less (at 100 kHz)

Z Axis

Sensitivity	0.5 Vp-p for noticeable intensity modulation. (Positive-going signal decreases intensity.)
Frequency Range	DC to 5 MHz
Input Resistance	5 kΩ ±10%
Maximum Input Voltage	50 V (DC + Peak AC)

Calibrator

Waveshape	Square wave
Repetition Rate	1 kHz Accuracy: ±1% (10°C to 35°C)
Duty Ratio	48% to 52%
Output Voltage	0.6 Vp-p Accuracy: ±1% (10°C to 35°C) ±1.5%(−10°C to 50°C)
Output Resistance	Approximately 300Ω
Output Current	(Offered as an option.) 5 mAp-p Accuracy: ±1% (10°C to 35°C)

Output Signal

Channel 1 Signal

Output Voltage	25 mV for each division of CRT display.
Frequency Response	DC to 20 MHz –3 dB
Output Resistance	Approximately 50Ω

A Gate

Output Voltage	Approximately 5 Vp-p, Positive-going (baseline at about 0 V)
Output Resistance	Approximately 300Ω

B Gate

Output Voltage	Same as A Gate.
Output Resistance	Same as A Gate.

Power Supply

Line Voltage	100 (90 to 110)/117 (106 to 128)/ 217 (196 to 238)/234 (211 to 257) VAC Selected by the Line Voltage Selector.
Line Frequency	50 to 400 Hz
Power Consumption	Approximately 100W (at 100V AC)

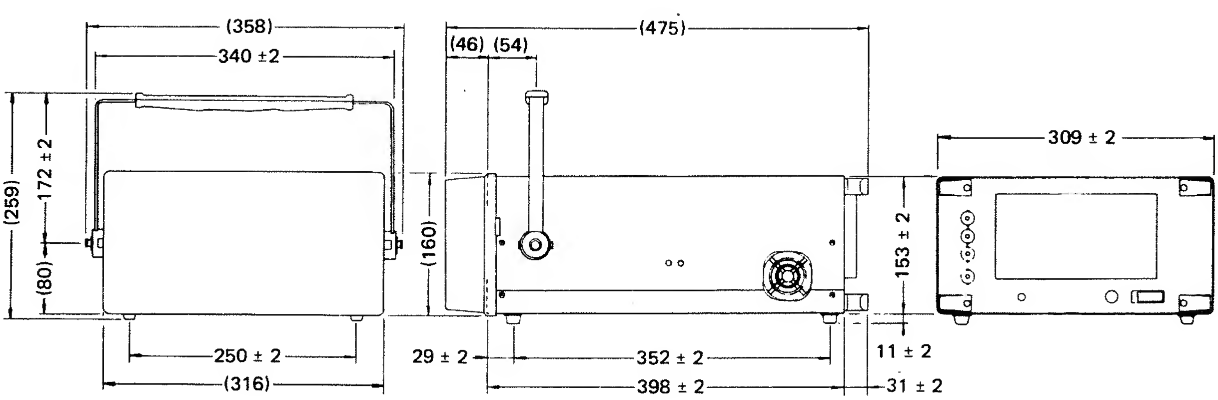
Physical Characteristics:

Cooling	Fored-air cooling
Weight	Approximately 11 kg
Dimensions	(309 ±2)W x (153 ±2)H x (398 ±2) L (mm) Refer to Fig. 1-1.

Environmental Characteristics:

Operating Temperature	–10°C to 50°C
Operating Humidity	90% RH, 40°C
Storage Temperature	–20°C to 70°C
Storage Humidity	80% RH, 70°C
Altitude	Operating: 5,000 m maximum (balometric pressure: 405 mmHg) Non-operating: 15,000 m maximum (balometric pressure:90.4 mmHg)
Vibration (non-operating)	Vibrate for 15 minutes along each axis at a total displacement of 0.67 mm p-p with the frequency varied from 10-55 Hz in one-minute cycle.

Fig. 1-1 Dimensions



Shock (non-operating)

Lift one bottom edge of the instrument 5 cm over a hard bench, and drop.
(30° maximum in elevation angle)
Repeate 3 times for each edge.

Drop (package drop)

Drop from a height of 90 cm on one corner, all edges radiating from that corner and all flat surfaces.

SECTION 2
OPERATING INFORMATION

How to use Handle

The handle of this instrument can turn and stop at an interval of 20 degrees when the levers of the lock mechanism at both ends of the handle are pressed in the OPEN direction in order to unlock. The handle can be used for carrying or as a stand for observation.

Then handle must be locked when it is not turned. If the handle is used as a carrying handle or a stand in an unlocked position, damage to the instrument may result.

CONTROLS AND CONNECTORS

The major controls and connectors for operation of the SS-5321 are located on the front panel of the instrument. A few auxiliary functions are provided on the rear panel and left and right sides. Figs. 2-1 and 2-2 show the front and rear panels and the left and right sides respectively. A brief description of each control and connector is given here. More detailed operating information is given in the later section "OPERATING INSTRUCTIONS".

Front Panel

—Power and CRT—

POWER

Power line switch. Power is supplied to the instrument when this switch is turned on and the pilot light glows.

INTEN (Black Knob)

Controls brightness of the display.

FOCUS (Red Knob)

Provides adjustment for optimum definition.

BEAM FIND

Compressively returns the display to the graticule area.

ENHANCE

Enhances brightness of displays within the ranges from 10 ns/div to 0.5 μs/div of the TIME/DIV switch. The light indicates when this switch is pushed in and go out when the switch is pulled out or when the TIME/DIV switch is set to a position outside of the six positions. In the single sweep operation, the enhancing acts by setting the TIME/DIV switch to the six positions without pushing of this switch. The enhancing does not act when the HORIZ DISPLAY switch is set to ALT.

SCALE

Controls brightness of scale illumination.

—Vertical Deflection System (CH1 to CH3)—

MODE

Selects the vertical mode of operation. The following modes can be selected:

CH1 : Displays Channel 1 only.

CH2 : Displays Channel 2 only.

ADD : Setting both buttons of CH1 and CH2 to the in position allows the ADD mode. Signals applied to the CH1 and CH2 input connectors are algebraically added and the sum is displayed on the CRT screen. The CH2 POLAR switch alows the display to be CH 1 + CH2 or CH1 − CH2.

ALT : Dual-trace display of signals on both channels. Display is switched between channels at the end of each sweep. Suitable for display of comparatively high frequency signals.

CHOP: Dual-trace display of signals on both channels. Display is switched between channels at an approximate repetition rate of 1 MHz. Suitable for display of comparatively low frequency signals.

X—Y: Operates as an X—Y scope of which the signals applied to the CH1 (X) and CH2 (Y) input connectors

Fig. 2-1 Front panel

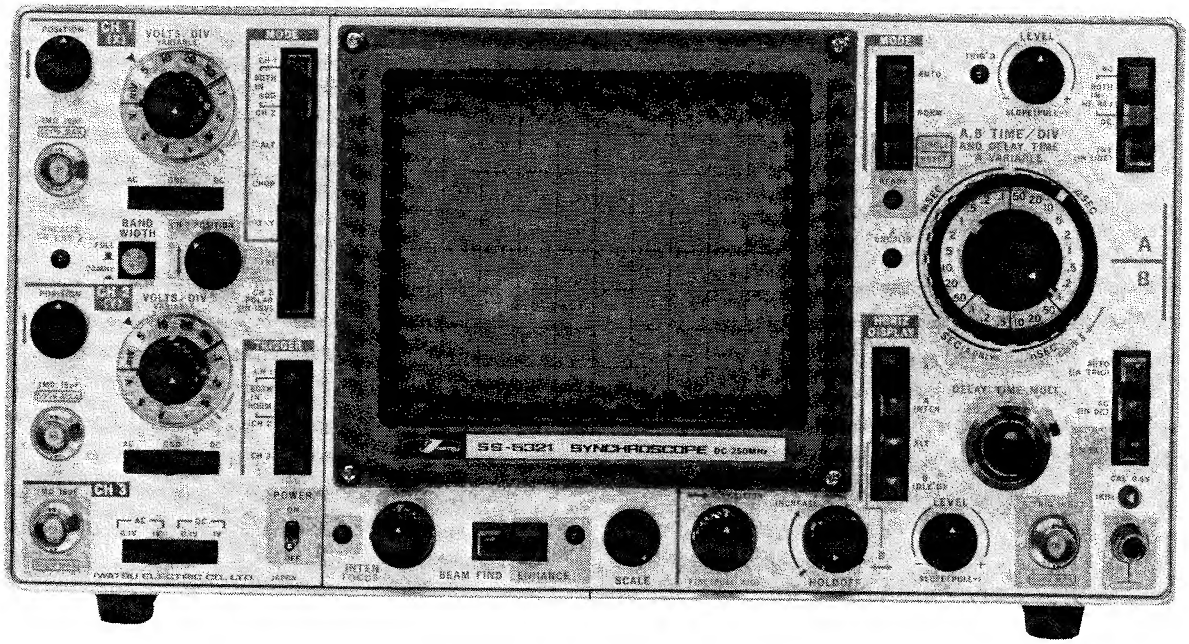
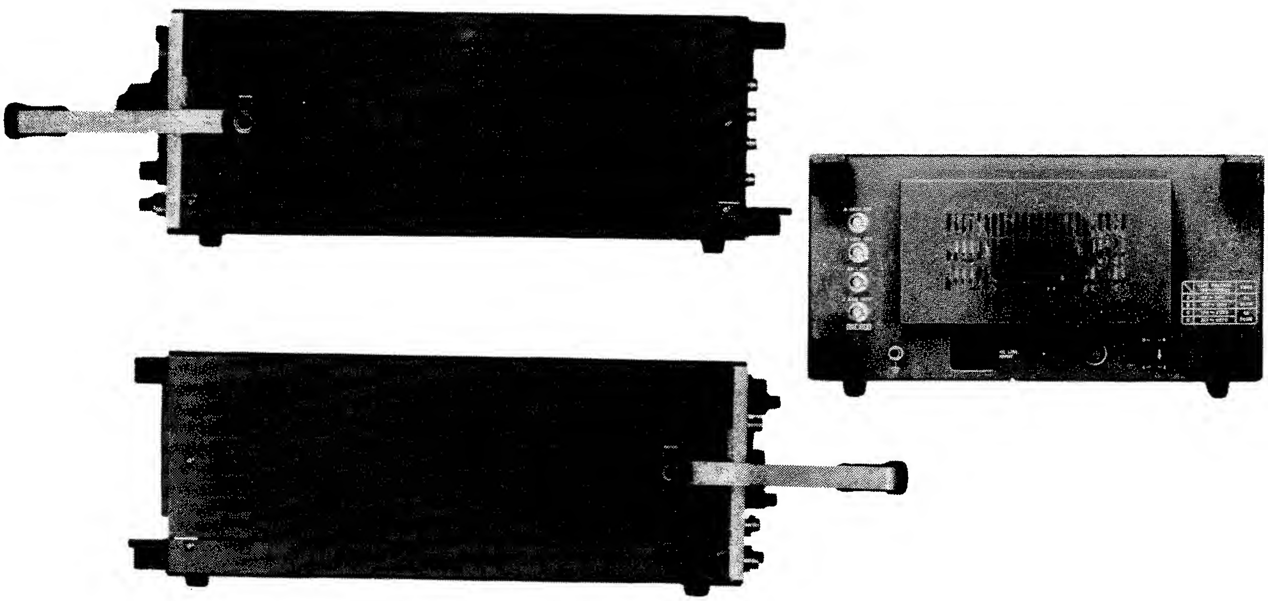


Fig. 2-2 Rear panel and left and right sides



deflect the X and Y axes respectively.

TRI

Provides triple-trace display of signals on three channels from Channel 1 to Channel 3. Display is switched between channels at the end of each sweep when the vertical MODE switch is set to ALT and at an approximate repetition rate of 1 MHz when the vertical MODE switch is set to CHOP.

CH2 POLAR

Switch to invert polarity of the Channel 2 display. The polarity is inverted by setting the button to the in position.

CH1 (X) Input Connector

Input connector for Channel 1 deflection signals or X-axis deflection in the X-Y mode of operation.

CH2 (Y) Input Connector

Input connector for Channel 2 deflection signals or Y-axis deflection in the X-Y mode of operation.

CH3 Input Connector

Input connector for Channel 3 deflection signals or external trigger signal.

AC-GND-DC

Selects the following signal input coupling.

AC : Signal is capacitively coupled to the Vertical Amplifier. DC component of signal is blocked. Low-frequency limit (low −3 dB point) is about 4 Hz.

GND : Input signal is removed from the input of the Vertical Amplifier and the input is grounded. Does not ground the input signal.

DC : All components of the input signal are passed to the Vertical Amplifier.

AC-DC (0.1 V −1V)

Selects signal input coupling and deflection factor of Channel 3.

VOLTS/DIV (Black Knob)

Selects vertical deflection factor in a 1-2-5 sequence (the VARIABLE control must be in the CALIB position for the indicated deflection factor).

VARIABLE (Red knob)

Provides continuously variable uncalibrated deflection factors between the calibrated settings of the VOLTS/DIV switch.

UNCALIB CH1 OR 2

Light indicates that the VARIABLE control is not in the CALIB position.

POSITION

Controls the vertical position of the display. In the X-Y mode of operation, the CH2 POSITION control positions on the Y-axis (vertical) and the Horizontal Position control and the FINE control position on the X-axis (horizontal).

CH3 POSITION

Controls the vertical position of the Channel 3 display.

BANDWIDTH

Changes the frequency bandwidth of Channel 1, 2 and 3. when the button is pulled out, the full bandwidth is provided. By setting the button to the in position, the bandwidth is narrowed to 20 MHz and trace noises may be cut.

TRIGGER

Selects source of trigger signal in internal triggering.

CH1 : A sample of the signal applied to the CH1 (X) input connector is used as a trigger signal in the ALT, CHOP or ADD mode.

CH2 : A sample of the signal applied to the CH2 (Y) input connector is used as a trigger signal in the ALT, CHOP or ADD mode.

NORM : Setting both buttons of CH1 and CH2 to the in position allows the NORM. Signal(s) displayed on CRT is used as trigger signal(s) in the CH1, CH2, ALT, CHOP or ADD mode.

CH3 : A sample of the signal applied to the CH3 input connector is used as a trigger signal in the CH1, CH2, ALT, CHOP or ADD mode.

– A TRIGGERING –

AC-HF REJ –DC

Selects the following trigger signal couplings:

AC : Rejects DC and attenuates signals below about 30 Hz. Signals above about 30 Hz pass.

DC : Accepts all trigger signals from DC to 250 MHz or higher.

HF REJ : Setting both buttons of AC and DC to the in position allows the HF REJ coupling. This coupling accepts signals between 30 Hz and 10 kHz. DC is rejected and all signals outside the above range are attenuated.

INT-LINE

Selects source of trigger signal.

INT : Pulling the button to the out position allows internal triggering. Signals selected by the TRIGGER switch are used as trigger signals.

LINE : Pushing the button to the in position allows line triggering. A sample of the line voltage signal applied to the instrument is used as a trigger signal.

LEVEL/SLOPE

Adjusts trigger level. This control also functions as the push-pull switch to select trigger slope. Positive-going slope is selected by pushing the knob in. Pulling it allows negative-going slope.

TRIG'D

Light indicates that triggering is obtained correctly.

– B Triggering –

AC-DC

Same as the AC-HF REJ-DC switch in the A Triggering excepting the HF REJ coupling. Setting the button to the out position allows the AC coupling and setting it to the in position allows the DC coupling.

INT-EXT

Selects source of trigger signal

INT : Pushing the button to the out position allows internal triggering. Signals selected by the TRIGGER switch are used as trigger signals.

EXT : Pulling the button to the in position allows external triggering. The trigger signal is obtained from signal connected to the TRIG INPUT connector.

TRIG INPUT

Input connector for external trigger signals.

LEVEL/SLOPE

Same as the LEVEL/SLOPE control in the A Triggering.

– Horizontal Deflection System –

HORIZ DISPLAY

Selects the horizontal display mode of operation. The following modes can be selected:

A : Displays A Sweep only.

A INTEN: Displays the A Sweep intensified by B Sweep.

ALT : Displays A Sweep and the B Sweep delayed to the A Sweep alternately.

B (DLY'D): Displays only the B Sweep delayed to the A Sweep.

A, B TIME/DIV AND DELAY TIME

A TIME/DIV switch (outer black knob) selects the sweep rate of the A Sweep and selects the basic delay.time to be multiplied by setting of the DELAY TIME MULT dial for delay-sweep operation. A VARIABLE control must be set to the CALIB position for calibrated A sweep rate and calibrated delay time.

B TIME/DIV switch (inner black knob) selects the sweep rate of the B Sweep for delay-sweep operation only.

A VARIABLE

Provides continuously variable A sweep rates between the calibrated settings of the A TIME/DIV switch.

A UNCALIB

Light indicates that the A VARIABLE control is not in the CALIB position.

MODE

Selects the operating mode for the A sweep circuit. The following modes can be selected:

AUTO : A Sweep can be triggered by signals that have repetition rate above 50 Hz and are within the frequency

range selected by the AC-HF REJ-DC switch. When the LEVEL control is turned to outside of the triggering range or no trigger signal is supplied to the trigger circuit, the sweep free-runs to produce a reference trace.

NORM : A Sweep can be triggered by signals that are within the frequency range selected by the AC-HF REJ-DC switch. When the LEVEL control is turned to outside of the triggering range or no trigger signal is supplied to the trigger circuit, the sweep stops.

SINGLE: Single sweep mode.

READY

Light indicates that A Sweep has been prepared to present a single sweep with receiving of an adequate trigger signal.

B ⇔ (Black Knob)

Controls the horizontal position of the display.

FINE (PULL X10) (Red Knob)

Finely controls the display horizontally. This control functions also as the pull switch that increases the displayed sweep rate by a factor of 10.

HOLDOFF

Control to eliminate the jitter which appears at observation for a complicated pulse train. The jitter is eliminated by turning this control from the NORM (fully counterclockwise) position to the INCREASE (clockwise)

⇔ (Red Knob)

Positions the trace of the B Sweep horizontally in the ALT position of the HORIZ DISPLAY switch.

DELAY TIME MULT

Provides variable sweep delay between 0.50 and 10.50 times the delay time set by the DELAY TIME switch.

CAL 0.6V

Terminal to provide a 0.6V square wave voltage signal with a repetition rate of approximately 1 kHz.

Left Side

DC BAL

Variable resistor for adjustment of the trace shift that appears when turning the VARIABLE control.

GAIN

Variable resistor calibrating the gain of the vertical deflection system.

Right Side

TRACE ROTATION

Variable resistor adjusting the either coincidental with or parallel to the graticule.

ASTIG

Variable resistor adjusting the focus of the trace with the FOCUS control.

Rear Panel

A GATE OUT

Output connector providing a positive-going square wave signal synchronized with the A sweep.

B GATE OUT

Output connector providing a positive going square wave signal synchronized with the B sweep.

CH1 OUT

Output connector providing a sample of the signal applied to the Channel 1 signal input connector.

Z AXIS INPUT

Input connector for intensity modulation of the CRT display.

Line Voltage Selector

Selects the operating voltage range of this instrument in accordance with the line voltage used.

FUSE

Fuse holder which contains a 2A or 1A slow-blow fuse according to the line voltage used.

OPERATING INSTRUCTION

Precautions

Ambient Temperature and Air Ventilation

The ambient temperature range of this instrument performing normal operation is from $-10°C$ to $+50°C$. The use of this instrument with the temperature exceeding this range may result in trouble; therefore, the operation in this range is essential. Moreover, do not place other devices or appratus on the ventilation hole of the cover in order to improve the efficiency of the heat radiation.

Check of Line Voltage

Desired operating voltage can be selected from four voltage ranges shown in Table 2-1 by the line voltage selector located on the rear panel. Check the line voltage prior to connection of the power cord, and set the selector so that its arrow mark can be lined with a voltage range indication on the panel which covers the line voltage. Note that mis-setting may result in trouble of the instrument.

Before changing the voltage range, check that a fuse shown in Table 2-1 is set in the fuse holder on the rear panel.

Table 2-1

Selector setting position	Center voltage	Voltage range	Fuse
A	100 V	90 to 110V	2A
B	117V	106to 128V	slow-blow
C	217V	196 to 238V	1A
D	234V	211 to 257V	slow-blow

Do not Intensify Unnessarily

The brightness of the spots or traces on the viewing area must not be increased excessively. Excessively intensified spots or traces may irritate an operator. If such spots or trances are stopped at the same position for a long time, it may result in burning of phosphorescence coating of the CRT.

Do not Apply an Excessively High Input Voltage

The rated maximum allowable input voltage for each input connector is as follows. Observe this restriction on voltage.

Signal input connector	500 V (DC + Peak AC)
Input of probe	600 V (DC + Peak AC)
TRIG INPUT	500 V (DC + Peak AC)
Z AXIS INPUT	50 V (DC + Peak AC)

Use in a Vertical Elevation Setting

This instrument can be used in the vertical elevation setting, namely, in positioning with the screen up. In this case, do not bring the instrument down by pulling a probe forcefully or by striking with other devices or apparatus.

Basic Operation

Powering and Sweeping

After the following operation, setting the POWER switch to on allows the Channel 1 trace to appear after approximately 15 seconds.

1. After confirming the line voltage, turn off the POWER switch, and connect the power cord to the line receptacle.
2. Set the controls as follows.

MODE (vertical)	CH1
TRI	Out position
POSITION (CH1)	Mid-position
INTEN	Mid-position
MODE (sweep)	AUTO
HORIZ DISPLAY	A
⇔ (horizontal Position)	Mid-position

Focusing

After the following operation, adjusting the FOCUS control makes the trace line thin and clear.

1. Shift the trace to the center on the viewing area by the CH1 POSITION control.
2. Set the A TIME/DIV switch to 1 mSEC.
3. Set brightness of the trace to desired degree by the INTEN control.

Triggering by Signal Apply

After the aforesaid operation, the following operation

allows most ordinary type triggering (AUTO operation by internal triggering and AC coupling).

1. Set the controls as follows.

AC-GND-DC (CH1)	AC or DC
VOLTS/DIV (CH1)	10 mV
VARIABLE (CH1)	CALIB
AC-HF REJ-DC	AC

2. Connect the CAL 0.6V terminal to the CH1 input connector using the accessory X10 probe.
3. Set the LEVEL control to the mid position.

The above-mentioned operation allows the triggering, and a 6 divisions calibration voltage waveform is displayed on the viewing area. For details of triggering, refer to the later section "Triggering".

Obtaining the Spot

After triggering, setting the CH1 AC-GND-DC switch to GND and the sweep MODE switch to NORM causes a spot to appear.

A spot can be also obtained by setting the vertical MODE switch to X-Y.

Single-Trace Operation

Setting the TRI switch to the out position and the vertical MODE switch to CH1 or CH2 allows the single-trace display of Channel 1 or Channel 2.

Dual-Trace Operation

There are two types of dual-trace modes: ALT (alternate display) and CHOP (chopped display).These modes can be selected with the vertical MODE switch by setting the TRI switch to the out position. By properly selecting these modes, dual-trace display can be performed for phenomena over a wide range from low speed up to high speed.

Dual-Trace Display by ALT

Setting the vertical MODE switch to ALT allows the sweeps of Channel 1 and Channel 2 to be effectes alternately. When the two signals to be measured are applied to both input connectors, the dual-trace measurement can be accomplished.

Alternate display covers the whole range of the TIME/DIV setting values, but when the sweep speed is very slow, two phenomena cannot be displayed at the same time because the sweeps are performed alternately. In the case of low speed signals of which measurement is effected with the TIME/DIV switch at the 2 mSEC or slower position, use the CHOP mode which will be explained below.

Dual-Trace Display by CHOP

The CHOP mode allows two phenomena to be displayed at the same time even if the sweep speed is slow. However, the chopped sweep is not suitable for high sweep speed operation. Since the Channel 1 and Channel 2 in the CHOP mode is switched at an approximate repetition rate of 1 MHz, high sweep speed, (when the TIME/DIV switch is set to approximately 5 μSEC or faster position) permits the trace to be displayed as a dotted line which is not easy to measure. In such cases, use the ALT mode.

In the CHOP mode, setting the AC-HF REJ-DC switch to HF REJ allows more stable triggering.

Added Display Operation

The ADD mode can be selected by setting the TRI switch to the out position and both buttons of CH1 and CH2 of the vertical MODE switch to the in position. In the ADD mode, signals applied to the CH1(X) and CH2(Y) input connectors are algebrically added and the sum is displayed on the CRT. Setting the CH2 POLAR switch to the out or in position allows the display of CH1 + CH2 or CH1 – CH2 respectively in the ADD mode.

Precautions for Added Display

1. When the added display is performed in differential input (the in position of the CH2 POLAR switch), set the AC-GND-DC switches of both channels to the same positions.
2. The POSITION controls of both channels allow shifting of the trace position. For correct measurement, set the POSITION controls to each mid-position.

Triple-Trace Operation

Setting the TRI switch to the in position allows the triple-trace display of Channel 1, Channel 2 and Channel 3. The three traces are alternately displayed at the end of each sweep when the the vertical MODE switch is set to a position other than CHOP and are displayed in the chopped operation with a repetition rate of approximately 1 MHz when the vertical MODE switch is set to CHOP.

Signal Application

The signal to be observed is applied to the input connector of Channel 1, Channel 2 or Channel 3. A probe is generally used as the means to connect the signal source with the input connector. The following probes can be used for this instrument; Type SS-0014 (1.5m length) with 10 : 1 attenuation, and Type SS-0001 (1m length), Type SS-0002 (1.5m length), Type SS-0003 (2m length) with 1 : 1 attenuation. The SS-0001 and SS-0003 probes are offered as an option.

The probes can protect the signal to be observed from the interference caused by the external electrical field. The 10 : 1 probes increase the input impedance and decrease the load effect to the signal source. So that, signals from higher output impedance sources and at higher frequencies can be correctly observed with the probes. As the 10 : 1 probes attenuate the signal to 1/10, the value indicated by the VOLTS/DIV switch must be multiplied by 10.

The 1:1 probes do not attenuate low frequency signals, and are convenient for low frequency signal observation. However, using the 1:1 probe increases the input impedance to (input RC of the instrument) + (input capacitance of the probe) and gives bigger load effect to a high frequency signal.

For the details,see the instruction manuals of the probes.

Signal Input Coupling

Many kinds of signals are measured; DC, AC and mixed signals. To observe these signals correctly, an adequate signal input coupling must be selected with the AC-GND-DC switch.

This switch selects the input coupling mode of the vertical deflection system: In the AC mode, the input connector and the input of the vertical amplifier are connected with a capacitor, in the DC mode, they are connected directly, and in the GND mode, they are disconnected altogether and the input of the vertical amplifier is grounded.

In the AC coupling, the capacitor blocks the DC component of the signal, and the displayed signal can be magnified without being deflected outside of the viewing area by the DC component. The AC coupling, however, produces sags in low frequency sqaure waves, or displays the decreased amplitude of sine waves. The amplitude decreases approximately 3 dB at 4 Hz. The DC coupling passes all components of the signal. The DC coupling is generally used if the DC component does not need to be blocked.

In the GND mode, the input of the vertical amplifier is grounded, and the ground level is traced on the viewing area. The level is used as the reference level in measurements.

Deflection Factor

For accurate measurement of signal waveforms, it is essential to display adequate amplitude of the waveforms on the viewing area. A signal which is excessively large or small in comparison with the viewing area can not be accurately measured. If the signal to be measured is small, it needs to be amplified, and if large, needs to be attenuated

The deflection factor is selected by the VOLTS/DIV switch and finely adjusted by the VARIABLE control. Each deflection factor becomes equal to the value indicated by the VOLTS/DIV switch when the VARIABLE control is set to the the fully clockwise position. The values show the voltage for one division on the viewing area. The sensitivity is decreased when the VARIABLE control is turned counterclockwise and becomes less than 1/2.5 of each indicated value at the fully counterclockwise position.

Cascade Connection

Lower deflection factors than provided by the VOLTS/DIV switch can be obtained with the cascade connection between Channel 1 and Channel 2.

The operating procedures are as follows.

1. Connect between the CH1 OUT (rear panel) and the Channel 2 input connectors using a 50Ω BNC cable (120 mm cable for maximum cascaded frequency response).
2. Set the MODE switch to CH2.
3. Set the VOLTS/DIV switches of Channel 1 and Channel 2 to 5 mV.
4. Turn the VARIABLE controls of Channel 1 and Channel 2 to the fully clockwise position, CALIB.

The above-mentioned operation allows the deflection factor of 1 mV/div. In this case, the trace may include noises. The trace is rated within 0.5 division in width. Moreover, the triggering may become unstable, but stable triggering can be obtained by setting the AC-HF REJ-DC switch to HF REJ.

Obtaining A Sweep

Setting the vertical MODE switch to any position other than X-Y and the HORIZ DISPLAY switch to A allows the A Sweep.

Triggering for A Sweep

A input signal waveform cannot be measured without triggering, therefore the correct operation for triggering must be understood sufficiently. This section describes the operating method of the A Triggering used for A Sweep. The B Triggering required for trigger delay will be described in later section "Delay Operation".

In order to obtain the triggering of A Sweep, the following must be selected; trigger source, internal trigger signal in internal triggering, trigger coupling, sweep mode, trigger slope and holdoff time.

The above five items are first described in detail, the the operating procedures will be described.

Trigger Source

In order to observe the input signal waveform on the viewing area by triggering, the input signal itself or a signal having an integer relationship with respect to the input signal in frequency (which is called a trigger signal) must be supplied to the trigger circuit in order to actuate the trigger generator which sends a trigger pulses and conducts the horizontal sweeping of display.

Setting the INT-LINE switch to INT allows the internal triggering which uses the signal divided from a channel selected by the TRIGGER switch as a trigger signal. Setting the INT-LINE switch to LINE permits the line triggering. In the line triggering, the line frequency signal is supplied from the power supply circuit to the trigger circuit as a trigger signal.

The internal triggering is recommended for ordinary measurements. The line triggering provides a stable triggering for measurements of line frequency signals or its harmonics.

A Triggering, external triggering, in which its trigger signal is displayed on the CRT is presented as a fucntion in internal triggering. The function is described in the following section "Internal Trigger Signal".

Internal Trigger Signal

In the internal triggering, the trigger signal is selected from each channel of the vertical deflection system in accordance with settings of the TRIGGER and vertical MODE switches as shown in Table 2-2.

In cases other than b, connection of trigger signal is needless because a signal to be measured is also supplied to the trigger circuit as a trigger signal. In these case, when the input signal frequencies are the same, selecting the channel to which the signal having higher amplitude and lesser noise component is applied allows stable triggering. When the input signal frequencies differ from each other (but, there is no phase shift between these signals), the one of the lower frequency should be used as the trigger signal. If the other signal having the higher frequency is used as the trigger signal, the one of the lower frequency is displayed in duplication. When a multi-trace is intended for measurement of phase difference between signals, the one with the leading phase must be selected as the trigger signal.

Case b corresponds to the above-mentioned external triggering. In this case, the trigger signal is free from influence of Channel 1 and Channel 2. In cases other than b, readjustment of the LEVEL control is often required to resume proper triggering level because changing the deflection factor allows trigger signal amplitude to vary.

The case of b needs no readjustment of the LEVEL control against any changing of the deflection factors of Channel 1 and Channel 2 so long as the trigger signal from Channel 3 is kept from variation. In addition, when it is desired to display the input signals of Channel 1 and Channel 2 with the trigger signal to be used as a reference signal in measurements, the input signals can be displayed by applying the reference signal to the Channel 3 input connector in the case of b. In this case, the reference signal (trigger signal) can be also displayed on the CRT by setting the TRI switch to the in position. Namely, this case corresponds to "Triple-trace display" in Table 2-2.

The NORM is the other tigger source. The NORM can be selected by setting both buttons of CH1 and CH2 of the TRIGGER switch to the in position. In the NORM, the waveforms displayed on the CRT are used as the trigger signal. The use of the NORM, for example, in the ALT position of the vertical MODE switch is convenient for comparison measurement of pulse width as the trigger signal changes between each channel according to the channel change of the vertical deflection, ie., each pulse is displayed from the same vertical line. In the CHOP mode, however, the NORM gives no stable triggering.

Notes:

In the single-trace display, the trigger signal is selected by setting of the vertical MODE switch when the TRIGGER switch is set to CH1 or CH2. This is designed to prevent a miss in trigger signal selection. Besides, this function can be dissolved by changing the pin-connection shown in Fig. 2-3 from D to I and this changing permits selection of the trigger signal by the TRIGGER switch only.

Fig. 2-3 Pin-connection

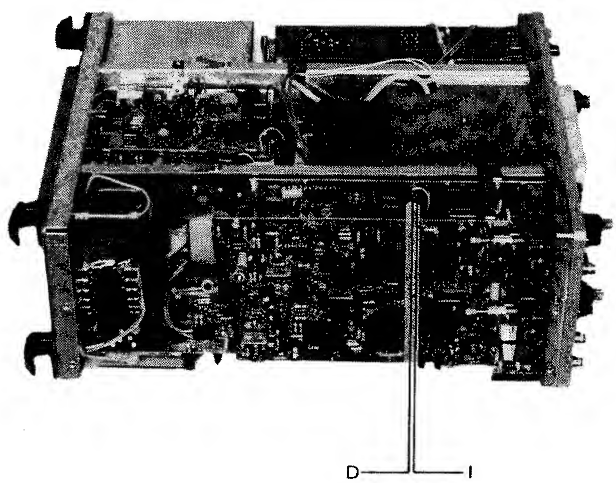


Table 2-2 Selection of internal trigger signal

Display	Channel to be selected (Trigger signal)	Operating for selection
Single-trace display	a. Channel connected to signal source to be measured (Channel 1 or Channel 2).	Set the vertical MODE switch to its channel (CH1 or CH2) and the TRIGGER switch to any position of CH1 or CH2.
	b. Channel 3.	Set the TRIGGER switch to CH3.
Dual-trace display	a. Channel to which a suitable signal is connected in the triggering (Channel 1 or Channel 2).	Set the TRIGGER switch to its channel (CH1 or CH2).
	b. Channel 3.	Set the TRIGGER switch to CH3.
Triple-trace display	Channel to which a suitable signal is connected in the triggering (Channel 1, Channel 2 or Channel 3).	Set the TRIGGER switch to its channel (CH1, CH2 or CH3).

Trigger Coupling

The AC-HF REJ-DC switch is designed to select the coupling mode between trigger signal and the trigger circuit. Three coupling modes are available: AC coupling, coupling by a low pass filter (HF REJ) and DC coupling.

These couplings are selected to obtain stable triggering in accordance with the kind of trigger signals, e.g., DC signals, AC signals, AC signals superimposed on DC and signals superimposed by high frequency noise.

AC : Passes the trigger signal to the trigger circuit through a capacitor, therefore DC and a low frequency component are rejected and attenuated respectively. Signals above about 30 Hz pass. This coupling is advantageous for ordinal signal measurements as the triggering is free from DC, but triggering is difficult when the trigger signal frequency is below about 30 Hz.

HF REJ: The trigger signal is supplied to the trigger circuit through a low pass filter which passes signals between 30 Hz and 10 kHz. Therefore, this coupling is advantageous for measurement of signals containing high frequency noise. This coupling also gives stable triggering for measurement of the composite video signal.

DC: Passes all trigger signals to the trigger circuit, so the triggering is possible from DC.

Sweep Mode

Two sweep modes, AUTO and NORM, can be selected by the sweep MODE switch. Each mode has the different feasures, so use one mode which is suitable for your needs.

In both modes, triggering is obtained in a certain range from the center of the LEVEL control and the range width varies according to the trigger signal amplitude.

In the AUTO mode, free-running sweep occurs when triggering is not accomplished, in other word, the LEVEL control is set to outside of the triggering range or no trigger signal is supplied to the trigger circuit. So the ground level trace is provided by setting the AC-GND-DC switch to GND. Triggering, however, is not obtained in signals below 50 Hz. In such cases, use the NORM mode.

In the NORM mode, the triggering is possible from DC, but the sweep stops when the triggering is not accomplished.

(Regarding the operation of the SINGLE mode, see the later section "Single Sweep Operation".)

Trigger Slope

The trigger slope can be selected with push-pull switching of the LEVEL control. Pushing the LEVEL control select, the positive-going slope, and pulling it permits the negative-going slope.

Holdoff Time

When the input signal has a complicated pulse train, the pulse train may be displayed in duplication in a certain sweep rate even if the triggering is obtained correctly.

Using the HOLDOFF control is useful in such case. The duplication can be eliminated by turning the HOLDOFF control slightly clockwise from the fully counterclockwise position.

Triggering Procedure I [Internal Triggering]

1. Set the INT-LINE switch to INT.
2. Set the sweep MODE switch to AUTO or NORM according to measurement objective.
3. Select a trigger signal by the TRIGGER switch.
4. Select a trigger coupling by the AC-HF REJ-DC switch.
5. Set the displayed amplitude of the input signal to the value higher than the prescribed one shown in Table 1-1.
6. Select a trigger slope and adjust the trigger level by the LEVEL control.

Triggering Procedure II [Line Triggering]

1. Set the INT-LINE switch to LINE.
2. Set the sweep MODE switch to AUTO or NORM.
3. Set the AC-HF REJ-DC switch to AC.
4. Select a trigger slope and adjust the trigger level by the LEVEL control.

Sweep Rate

The signals to be observed vary in many ways, from high to low repetition frequencies, or from fast to slow rise time pulses. In order to observe such signals, a suitable sweep rate must be selected according to the repetition frequencies or the rise time.

In the A Sweep, the sweep rate is selected by the A TIME/DIV switch. Each setting value is slowed down when turning the A VARIABLE control counterclockwise and

set less than 1/2.5 of the value at the fully clockwise position, CALIB.

The sweep rate of the B Sweep is always calibrated to the value indicated by the B TIME/DIV switch as no variable control is presented.

Sweep Magnifying

A part of the input waveform can be magnified with regard to time by the use of faster sweep rate. However, the part which is far from the sweep start position may be out of the viewing area when the sweep rate is increased.

The part to be measured can be magnified 10 times by shifting its part to the center of the viewing area with the Horizontal Position control and then pulling the FINE (PULL x10) knob. Entire length of the trace is magnified to approximately 100 divisions wide though only the center 10 divisions part is displayed in the viewing area. The magnified trace can be fully observed by sequentially adjusting the Horizontal Position and FINE controls.

The sweep rate at 10 magnification can be calculated by multiplying the TIME/DIV setting value by 1/10.Therefore, the maximum available sweep rate can be obtained by the following calculation: 10 ns/div (the maximum sweep rate at no magnification) x 1/10 = 1 ns/div.

Delay Operation

The above mentioned magnification of display is a simple operation and is useful to obtain a maximum sweep rate 10 times faster than the setting valve of the TIME/DIV switch. However, the magnification factor is limited to 10 times. In the case of sweep magnification by the delay operation, the limitation of magnification factor can be enlarged to an extent determined by the ratio of A sweep rate to B sweep rate.

Note that the magnification by the delay operation is limited by applicable input signal frequencies. In other words, if the input signal frequency is so high that the A TIME/DIV switch is set to the highest speed position before magnification, no further magnification is obtainable. It should be understood that the sweep magnification by the delay is very useful for magnivying an arbitrary portion of comparatively low frequency signals.

The magnification by the delay includes the following two modes: automatic sweep and triggered sweep.

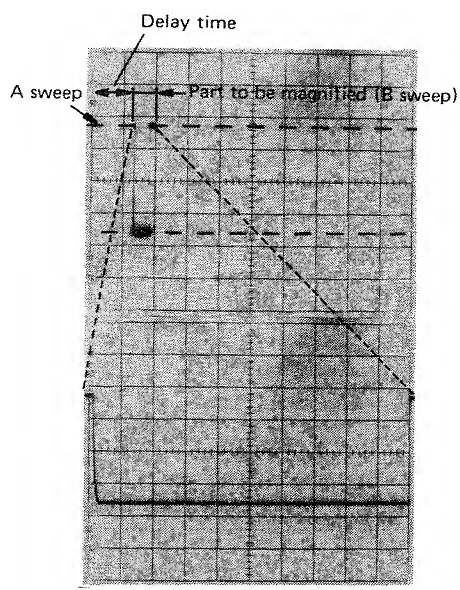
Automatic Sweep

The operating procedures are as follows:

1. Set the HORIZ DISPLAY switch to A.
2. Apply the signal to be measured to the signal input connector and obtain triggering for the input signal.
3. Decrease the brightness of the trace a little.
4. Set the B TIME/DIV switch to a position higher than that of the A TIME/DIV switch.
5. Set the AUTO-TRIG switch to AUTO.
6. Set the HORIZ DISPLAY switch to A INTEN.

After this procedure, unlocking the lock of the DELAY TIME MULT control and turning it clockwise allows an intensified part to appear as shown in Fig. 2-4 and to shift rightward continuously. When the intensified part is shifted to the position to be magnified,setting the HORIZ DISPLAY switch to B (DLY'D) permits the part to be magnified fully on the viewing area. The sweep rate of the B (DLY'D) sweep is determined by the B TIME/DIV

Fig. 2-4 Magnification by automatic sweep



switch. Making the higher sweep rate gives higher magnification factor, but excessivly high magnification factor causes a delay jitter. Therefore, the magnification by the automatic sweep is limited by the delay jitter. However, the magnification factor can be increased by the triggered sweep which will be described later.

The delay time for the magnified part can be obtained by the following calculation: Multiply Setting valve of the dial by Setting value of the A TIME/DIV switch.

Triggered Sweep

Setting the AUTO-TRIG switch to TRIG allows the triggered sweep. The magnified part can be displayed by the same procedure as that of the above-mentioned automatic sweep.

Magnified part (B Sweep) in the triggered sweep starts at a preset triggering point for B Sweep after the delay time is given by the DELAY TIME MULT control. By turning the DELAY TIME MULT control, the intensified part (to be magnified) jumps from rising edge to rising edge of the A Sweep waveform. The jumping can occur at each falling edge of the signal when the LEVEL control is pulled in order to set the trigger slope to negative. When the AUTO-TRIG switch is set to TRIG and the HORIZ DISPLAY switch is set to B (DLY'D), turning the DELAY TIME MULT control causes no shift of the displayed waveform on the viewing area; however, the displayed waveform in this case is the part selected in the A INTEN Sweep.

Operation of B Triggering

The following controls and connector are presented for B triggering:

LEVEL/SLOPE: Same as the LEVEL/SLOPE switch in the A triggering.

AC-DC: Same as the AC-HF REJ-DC switch in the A triggering excepting the HF REJ coupling.

INT-EXT: Selects source of trigger signal. Pulling the button to the out position allows internal triggering and signals selected by the TRIGGER switch are used as the trigger signal. Pushing the button to the in position permits external triggering and an external signal connected to the TRIG INPUT connector is used as the trigger signal.

TRIG INPUT: Input connector for external trigger signal.

Alternate Sweep

The alternate sweep displays A Sweep (unmagnified part of the display) and the B Sweep (magnified part) delayed to the A Sweep. This display mode is convenient in comparison with the above-mentioned delay sweep as the magnified parts are displayed sequentially after the unmagnified part in one trace.

The operating procedures are as follows:

1. Set the HORIZ DISPLAY switch to A.
2. Apply the signal to be measured to the signal input connector and obtain triggering for the input signal.
3. Decrease the brightness of the trace a little.
4. Set the AUTO-TRIG switch to AUTO.
5. Set the B TIME/DIV switch to a position which is higher than that of the A TIME/DIV switch.
6. Set the HORIZ DISPLAY switch to ALT.
7. Shift the start point of the B Sweep to the end of the A Sweep by the B Sweep Horizontal Position control.
8. Shift the B Sweep to the part Sweep to be magnified of the A by the DELAY TIME MULT control.
9. Select a magnification factor by changing the B TIME/DIV switch.

The delay time for the magnified part can be obtained by the equation shown in "Delay Operation". Excessively high magnification factor causes a delay jitter, but the magnification factor can be increased further by the triggered sweep which is given by setting the AUTO-TRIG switch to TRIG.

Single Sweep Operation

Many transient effects are seen in daily use such as chattering of relay contact or discharging waveform. Such transients can be observed correctly by using the single sweep function in which sweeping of display takes place only once when triggered and by photographic recording.

In this section, the basic operation for the single sweep will be described assuming that calibration voltage output is supplied to the input.

1. Set the HORIZ DISPLAY switch to A and the sweep MODE switch to NORM.
2. Connect the CAL 0.6V terminal to the signal input connector using a probe, and obtain positive triggering

after selecting a optimum deflection factor and sweep rate.

3. Set the sweep MODE switch to SINGLE, and push the RESET button in order to check that the sweep is performed only once.
4. Disconnect the connection of the calibration voltage output, and push the RESET button again in order to check that the READY indicator is lightened.

When the above procedure causes the indicator to light up, the ready state (the state which offers only one sweep by a trigger signal) is obtained. In this state, if a transient effect is applied to the the signal input connector, the transient effect is displayed correctly with the single sweep.

Also in external triggering, this single sweep is available if the external trigger signal has roughly the same operation as that for the calibration voltage output given in item 4 above.

The single sweep is impossible for the simultaneous dual trace in the alternate sweep, but it is possible in the chopped sweep.

X—Y Operation

The X-Y scope operation gives phase difference measurement, hysteresis loop observation, etc.

This instrument can be used as an X-Y scope by setting the vertical MODE switch to X-Y. A spot appears at the mid-position of the trace. Applying signals to the signal input connectors of Channel 1 and Channel 2 allows the Channel 1 signal to drive the X-axis and the Channel 2 to drive the Y-axis respectively in order to display a Lissajou's pattern.

The deflection factor of the X-axis is determined by the VOLT/DIV switch and the VARIABLE control of Channel 1. The deflection factor of the Y-axis is decided by the VOLTS/DIV switch and the VARIABLE control of Channel 2. The display can be shifted vertically and horizontally by the Channel 1 POSITION control and the Horizontal Position and its FINE controls respectively.

SECTION 3
MEASURING INSTRUCTION

Probe Phase Adjustment

Proper adjustment of the probe phasing is required before measurements as the incorrect phasing results in erroneous measurements when the 10:1 probe is used.

1. Set the controls as follows:

VOLTS/DIV	10mV
VARIABLE	CALIB
TIME/DIV	0.5 mSEC
VARIABLE	CALIB
FINE (PULL X10)	Pushed state

2. Connect the probe between the input connector and the CAL 0.6 V terminal.
3. Display the calibration voltage waveform with six divisions amplitude.
4. Adjust the variable capacitor of the probe (located in a hole of the input connector side) using the accessory adjustment driver, and set the top of the waveform to the correct phasing shown in Fig. 3-1.

Voltage Measurement

Quantitative Measurement

The quantitative measurement of voltage can be performed by setting the VARIABLE control to the CALIB position. The measured value can be calculated by Equation (1) or (2).

a. Measurement without probe

Voltage (V) = VOLTS/DIV setting value (V/div) x Displayed amplitude of input signal (div) . . . (1)

b. Measurement with probe

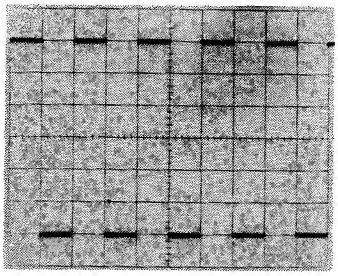
Voltage (V) = VOLTS/DIV setting value (V/div) x Displayed amplitude of input signal (div) x Reciprocal number of prove attenuation . . . . (2)

DC Voltage Measurement

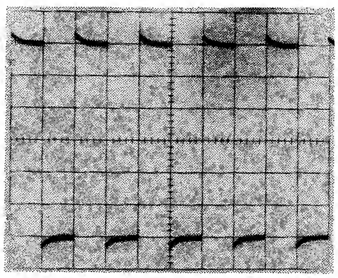
This instrument functions as a high input resistance, high sensitivity, quick response DC volt meter in order to measure DC voltage. Measurement procedure is as follows:

1. Set the sweep MODE switch to AUTO, and select a sweep rate so that the trace may not flicker.
2. Set the AC-GND-DC switch to GND. The vertical position of the trace in this case is used as 0-volt reference line as shown in Fig. 3-2. Adjust the vertical POSITION control in order to place the trace exactly on a horizontal graticule, which facilitates the reading of signal voltage.
3. Set the AC-GND-DC switch to DC, and apply the voltage to be measured to the input connector. The vertical

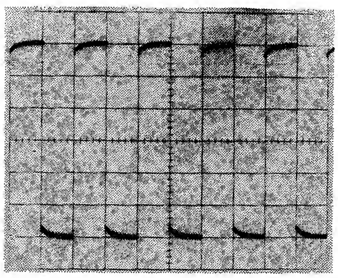
Fig. 3-1 Probe phasing and displayed waveform



Correct Compensation



Excessive Compensation



Insufficent Compensation

diaplacement of the trace gives the voltage amplitude of the signal. When the trace shifts upward, the measured voltage is positive with regard to the ground potential. When the trace shifts downward, the voltage is negative. The voltage can be obtained by Equation (1) or (2). (In this measurement, the CH2 POLAR switch must be set to the out position.)

AC Voltage Measurement

The measurement of the voltage waveform is performed as follows: Set the VOLT/DIV switch in order to obtain the amplitude for easy reading, read the amplitude as shown in Fig. 3-3, and calculate by Equation (1) or (2).

When the waveform superimposed on DC current is measured, set the AC-GND-DC switch to DC in order to measure the value including DC component, or set this switch to AC in order to measure AC component only.

The measured value by means of this procedure is peak value (Vp-p). Effective value (Vrms) of a sine wave signal can be given by Equation (3).

$$\text{Effective voltage (Vrms)} = \frac{\text{Peak voltage (Vp-p)}}{2\sqrt{2}} \quad \ldots.(3)$$

Time Measurement

The time interval of two points on a signal waveform can be calculated as follows: Read the setting values of the TIME/DIV and x10 switches and calculate the time by Equation (4). In the A Sweep, set the A VARIABLE control to the CALIB position.

Time (s) = TIME/DIV setting value (s/div)
x Length corresponding to the time to be measured (div)
x Reciprocal number of x10 setting value
. . . . (4)

(Where the reciprocal number of the x10 setting value is

Fig. 3-2 DC voltage measurement

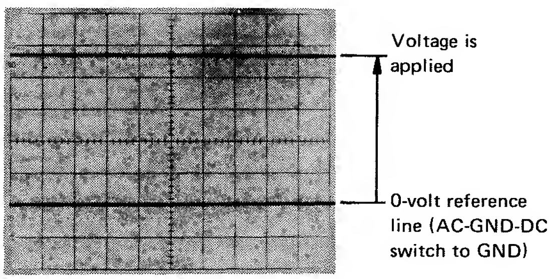


Fig. 3-3 AC voltage measurement

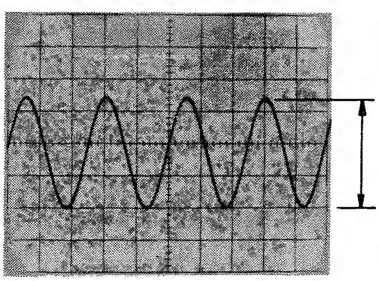


Fig. 3-4 Pulsewidth measurement

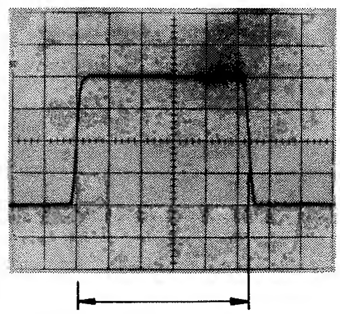
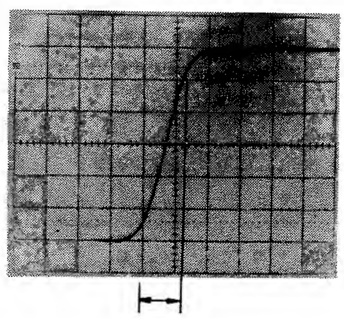


Fig. 3-5 Rise (or fall) time measurement



1 when the sweep is not magnified, and 1/10 when the sweep is magnified.)

Pulsewidth Measurement

The basic pulsewidth measurement procedure is as follows:

1. Display the pulse waveform vertically so that the distance between the top part of the pulse waveform and the horizontal center line of the graticule may be equal to the distance between the bottom part of the pulse and the horizontal center line as shown in Fig. 3-4.
2. Set the TIME/DIV switch for easy observation of the signal.
3. Read the distance between the centers of rising and falling edges, i.e., the distance between two points at which pulse edges cross the horizontal center line of the graticule. Calculate the pulsewidth by Equation (4).

Rise (or Fall) Time Measurement

The rise (or fall) time measurement of the pulses is obtained as follows:

1. Adjust the amplitude of the pulse waveform to 6 divisions in the 6 central vertical divisions of the graticule as shown in Fig. 3-5.
2. Set the TIME/DIV switch in order to make the easy observation of the rising (falling) edge.
3. Read the distance between the lower and upper 10% points of the rising (falling) edge refering the 10% dotted lines of the graticule. At this time, setting the lower or upper 10% point to any vertical line within the 8 central horizontal divisions allows easy reading. (See Fig. 3-5).
4. Calculate the rise (fall) time by Equation (4).

Frequency Measurement

Frequency can be measured by the following methods: following methods.

The first method: Calculate the one-cycle time (interval) of the input signal by Equation (4) as shown in Fig. 3-6, and obtain the frequency by Equation (5).

$$\text{Frequency (Hz)} = \frac{1 \text{ (c)}}{\text{Period (s)}} \quad \dots\dots\dots\dots\dots (5)$$

The second method: Count the repetition number N per 10 divisions in the viewing area, and calculate the frequency by Equation (6).

$$\text{Frequency (Hz)} = \frac{\text{N (c)}}{\text{TIME/DIV setting value (s/div)} \times 10 \text{ (div)}} \quad \dots (6)$$

When N is large (30 to 50), the second method can give a higher accuracy level than that obtained with the first method. This accuracy is approximately equal to the rated accuracy of sweep rate. However, when N is small, the count below decimal point becomes very ambiguous, which results in considerable error.

For the measurement of comparatively low frequencies having a simple pattern such as sine wave, square wave, triangle wave, and sawtooth wave, measurement with high accuracy can be effected by the following method: Operate the oscilloscope as an X-Y scope, make the Lissajou's pat-

Fig. 3-6 Frequency measurement (1)

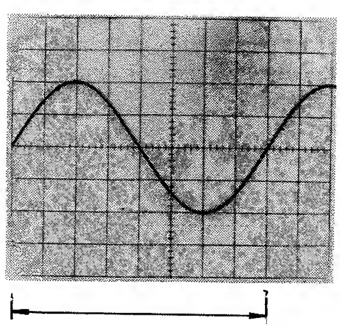
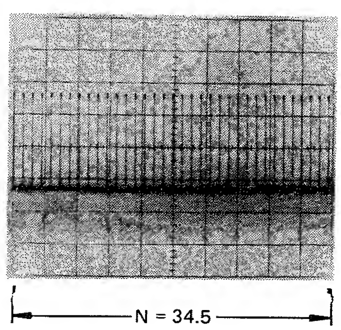


Fig. 3-7 Frequency measurement (2)



tern by applying the signal whose frequency is known, and read the necessary value.

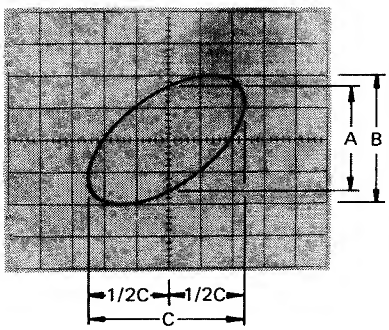
Phase Mearsurement

The following two methods can be used to measure phase difference between two signals:

The first one is Lissajou's pattern method using the the instrument as an X-Y scope. The phase difference of signals can be calculated form the amplitudes A and B of the pattern shown in Fig. 3-8 and by Equation (7).

$$\text{Phase difference (deg)} = \sin^{-1}\frac{A}{B} \quad \text{.........} \quad (7)$$

Fig. 3-8 Phase difference measurement using Lissajou's pattern



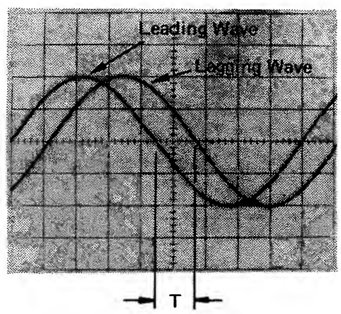
The second method is an application of dual-trace function. Fig. 3-9 shows an example of dual-trace display of leading and lagging sine wave signals having the same frequency. In this case, the TRIGGER switch must be set to a channel which is connected to the leading signal, and set the TIME/DIV switch so that the length of 1-cycle of the dispalyed sine wave may be 9 divisions.

Then, 1-division graticule represents a waveform phase of 40° (1 cycle = 2π = 360°). The phase difference between the two signals can be easily calculated by Equation (8).

$$\text{Phase difference (deg)} = T\ \text{(div)} \times 40^\circ \quad \text{.........} \quad (8)$$

(Where T is the distance between two points at which the leading and lagging signals cross the horizontal center line of the graticule.)

Fig. 3-9 Phase difference measurement by dual-trace display

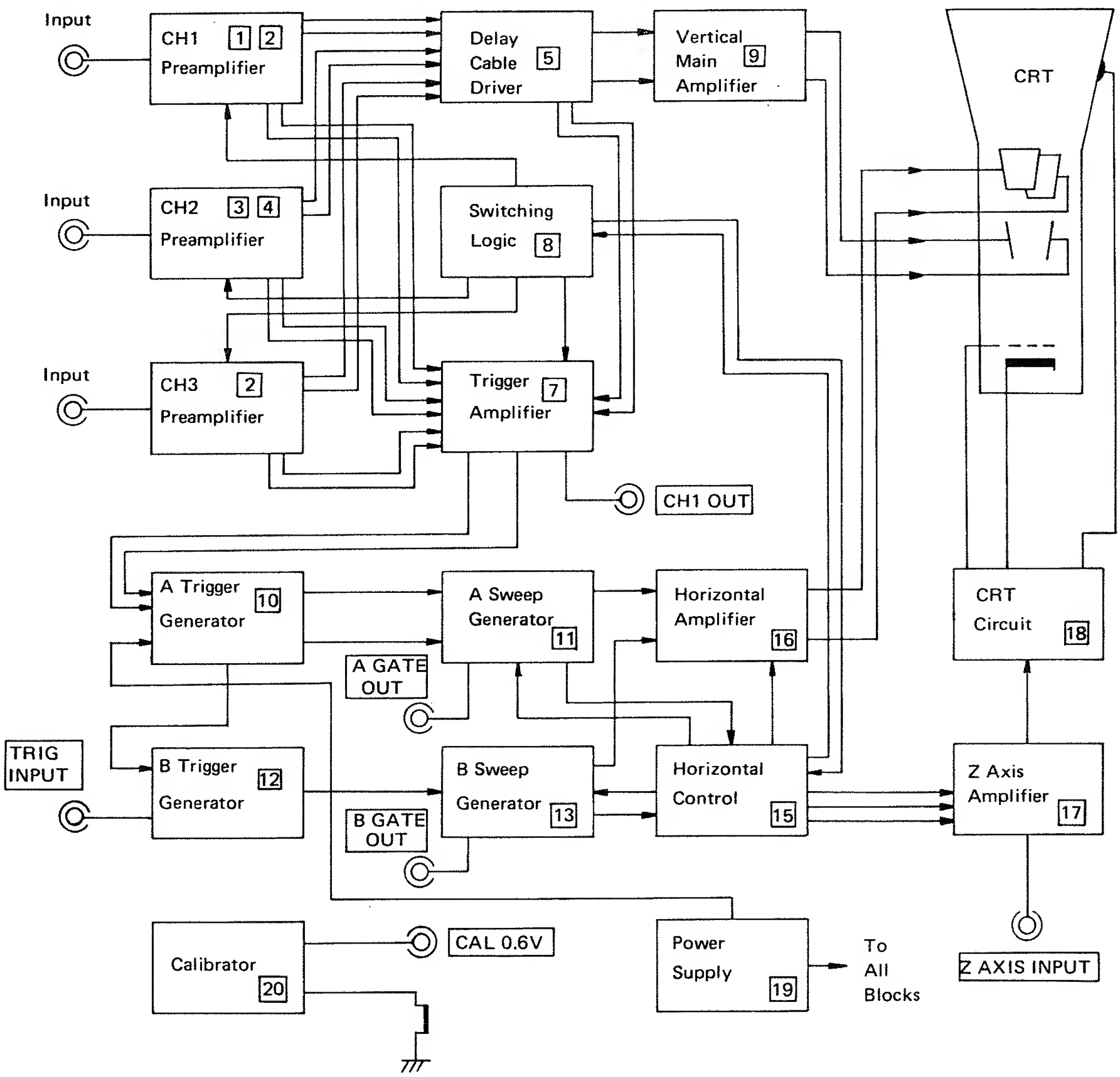


SECTION 4
OPERATING PRINCIPLES

A basic block diagram of the SS-5321S is shown in Fig. 4-1.

The Vertical Deflection System contains three independent Preamplifiers. Signals to be displayed on the CRT are

Fig. 4-1 Overall block diagram



applied to either the Channel 1 and/or Channel 2 and/or Channel 3 input connectors, converted into a push-pull output signal and amplified and connected to the Delay Cable Driver.

The vertical MODE switch selects following six modes when the TRI switch is set to the out position; Either Channel 1 or Channel 2 alone, the two signals electronically switched (ALT or CHOP), the algebraic sum (ADD) or difference of the two signals or the X-Y mode to operate the instrument as an X-Y scope. In the ALT mode, the diode switching circuits of the CH1 and CH2 Preamplifiers are driven by a alternate signal supplied from the A Sweep Generator through the Horizontal Control and Switching Logic circuits, resulting in an alternate display of the Channel 1 and Channel 2 signals as complete sweeps. In the CHOP mode, the chop multi circuit of the Switching Logic circuit oscillates on a free-running basis at a repetition rate of approximately 1 MHz which switches the diode switching circuits causing the output signals from the two channels to be chop-displayed at a repetition rate of approximately 1 MHz regardless of the sweep rate. In this mode, the chop blanking signal is supplied to the Z Axis Amplifier to blank the transients of the switching action. When the TRI switch is set to the in position, the alternate triple-trace display is provided in a position other than CHOP and X-Y of the vertical MODE switch and the chopped triple-trace display is provided in the CHOP position of the MODE switch.

The input signal is also supplied from each trigger pickoff circuit of the Preamplifiers to the Trigger Amplifier where it is amplified and supplied to the A and B Trigger Generators. The Channel 1 input signal is amplified in the CH1 signal amplifier of the Trigger Amplifier circuit and supplied to the CH1 OUT connector.

The Vertical Main Amplifier provides the final amplification and deflects the beam vertically in the CRT.

The A and B Trigger Generator circuits convert trigger signals of their inputs into first-rise trigger pulses which initiate the sawtooth signals produced by the A or B Sweep Generator circuit.

The A Sweep Generator circuit produces a linear sawtooth signal of which the slope is determined by the A TIME/DIV switch. The output of the A Sweep Generator is connected to the B Sweep Generator to provide the delayed sweep. The slope of the B sawtooth signal is determined by the B TIME/DIV switch. The A and B Sweep Generators also produce unblanking gate signals to unblank the CRT. The gate signal coincident with the A or B sawtooth is supplied to the A or B GATE OUT connector respectively.

The Horizontal Amplifier provides the amplification of the sawtooth signals or the X-axis signal in the X-Y mode and deflects the beam horizontally in the CRT.

The Z Axis Amplifier circuit determines the CRT intensity and blanking. This circuit sums current inputs from the INTEN control, A and B gate circuits and external Z AXIS binding post. The output of this circuit is connected to the control grid of the CRT.

The CRT circuit produces the high voltage supply required to emit and accelerate the beam of the CRT.

The Power Supply circuit produces the 6.3 V AC supply used for the graticule illumination lamps and the low DC voltage supplies to operate each circuit of this instrument.

The Calibrator circuit produces a square-wave signal with accurate amplitude and frequency which can be used to check the deflection factor, sweep rate and compensation of the probes.

SECTION 5
MAINTENANCE

Warning

The following precautions must be observed when maintenance work is done:

1. There are many potentially dangerous areas is this instrument.

2. When the instrument is operated with the cover removed, do not touch exposed connections or components.

3. Some transistors may have elevated cases and heat sinks in the voltage.

4. Always disconnect the instrument from the power source before cleaning the instrument or replacing parts.

Cover Removal

The top and bottom covers can be removed by loosing six mounting screws on each cover.

PREVENTIVE MAINTENANCE

These precautions on preventive maintenance will protect the instrument and keep it clean over a long period of time.

Cleaning

Since the extent of instrument smearing depends on the ambient condition in which the oscilloscope is used, the frequency of the cleaning operations will varn. Clening should be done as required. Dust deposited inside the instrument affects the normal flow of cooling air and invites the local overheating of component parts. Smeared switch contacts of connector pins can be the cause of defective contacts, and smearing of the circuit can cause arcing between circuits, particularly in humid weather.

Cleaning agents recommended and those prohibited are listed in Table 5-1.

Table 5-1

Recommended agent	Alcohol, gasoline of kerosene
Prohibited agent	Acetone, tri-ethyl-ketone, ether, lacquer thinner or agent containing ketone series solvent.

Cleaning the Cover

Normal smearing of the cover can be cleaned by washing the cover with a neutral chemical cleaner. For greasy smearing, use a recommended agent in Table 5-1 with a soft cloth.

Front and Other Panels

Clean the smeared panel with a soft cloth moistened with a recommended agent. Note that cleaning with alcohol may leave slight blotting. A neutral chemical cleaner may be used by the clearn left on a panel or knob must be removed with a cloth soaked in water.

Dust in Instrument

The best way to remove dust inside the instrument is by spraying with compressed air. Remove persistent dust with a soft paint brush and spray the air again.

CRT

The CRT screen will be smeared if it is used for too long

without the filter. Ordianry dust or fingerprints left on the CRT can be cleaned with a soft cloth. Use a soft cloth moisted with alchol to remove persistent smearing.

Filter

The filter may become clogged when used for a long time. Dust or fingerprints can be cleaned with a dry, soft cloth. Use a soft cloth moistened with alcohol to remove persistent smearing.

Before Storing the Osilloscope

Before storing the oscilloscope, remove the probe store it in a dry place to prevent deposition of dust. the accessory bag provided. Cover the oscilloscope, and store it in a dry place. It prevents deposition of dust.

Visual Inspection

Periodically inspect the condition of the internal circuit. Burnt resistors, defective connection contents, broken printed circuit board and many other defects can be checked easily. Prompt repair of these minor defects can prevent or limit problems to a minor level.

Periodical Calibration

In order to use the oscilloscope accurately, periodical calibration of circuits is essential. When this oscilloscope is used frequently, a calibration will be required at every 1000 hours of operation. The frequency of calibration may be extended to 6 months, if the oscilloscope is used infrequently.

TROUBLESHOOTING

Troubleshooting Reference

Schematic Diagrams

In this manual, schematic diagrams are grouped, in general, with the circuit blocks classified in Fig. 4-1.

Circuit Layout

Layout of circuits on the printed circuit boards is shown in Figs. 5-1 to 5-4. Use the photographs for inspection.

Parts Layout

Refer to part No. printed on the printed circuit board to identify parts mounted on the board.

Color Code of Resistors and Capacitors

Most of the resistors and capacitors in the circuit are color coded by resistance or capacitance value. See Fig. 5-5 for the color code.

Electrode Markings of Diodes and Transistors

Tables 5-2 and 5-3 show the electrode markings of diodes and transistors, by type.

Instruments Required for Troubleshooting

The following instruments are the minimum required for troubleshooting of this oscilloscope.

(1) Multimeter

Input resistance	:	10 MΩ
Voltage range	:	0 to 300V and special position for 2 kV
Ohm-range	:	0 to 10 MΩ

(2) Transistor curve tracer

(3) Oscilloscope

Frequency bandwidth	:	DC to 50 MHz
Sensitivity	:	5 mV/div

Fig. 5-1 Circuit layout (top)

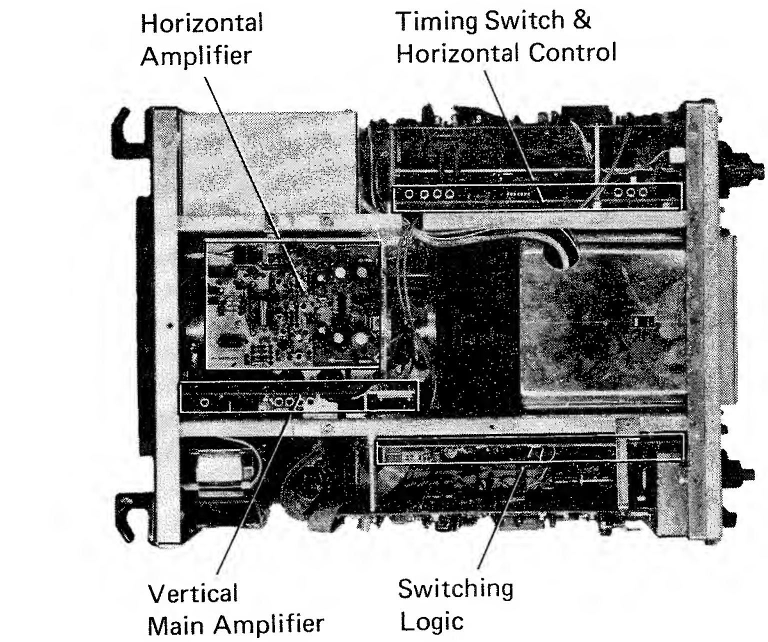


Fig. 5-2 Circuit layout (left side)

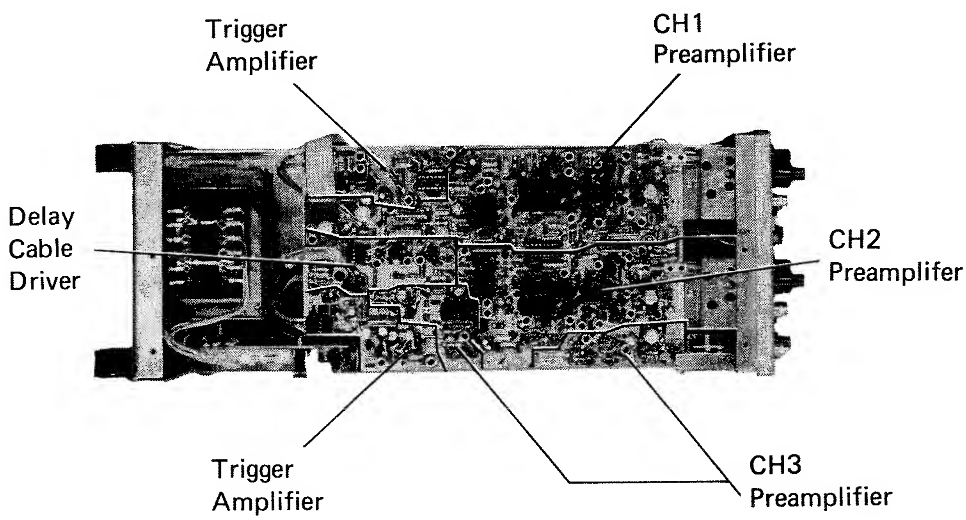


Fig. 5-3 Circuit layout (right side)

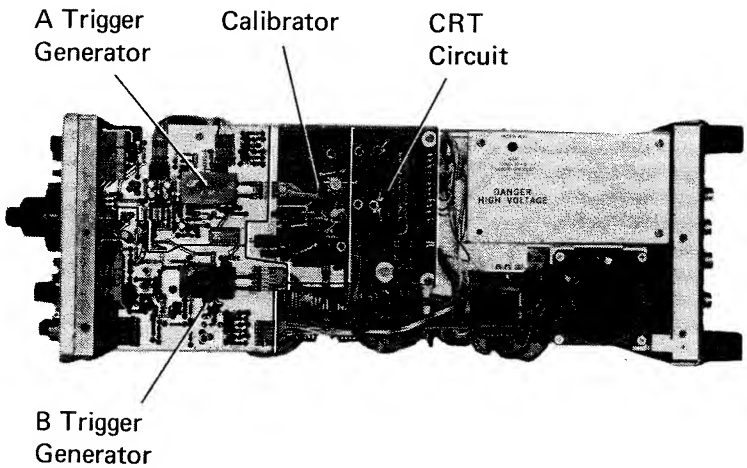
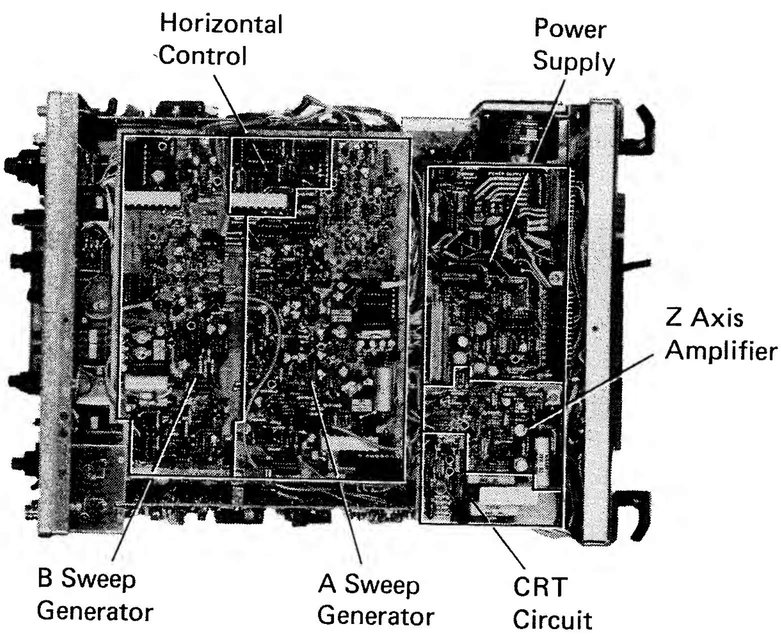


Fig. 5-4 Circuit layout (bottom)



Troubleshooting Steps

The first priority of troubleshooting is to examine if an irregular event like "circuit trouble" is really due to a defect within the circuit, or caused by external events. For example, what seem to be malfunctions can occur in a normal oscilloscope if the line voltage is out of the rated voltage range, or a signal input connector is affected by induction of an external signal.

Then, repeatability of the trouble must be checked. For example, when sweep is normal but an irregular signal is displayed with a signal supplied to the signal input connector, the other signal must be supplied to the input to check if the same irregular display occurs (if it does, the oscilloscope is responsible).

When troubles persist after these perliminary checks, the following actual steps must be performed:

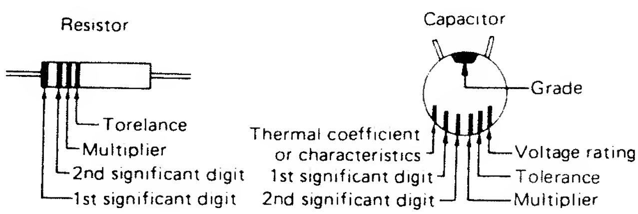
1. Remove the covers from the instrument and ascertain the defective circuit by the troubleshooting flow chart shown in Fig. 5-6.
2. Visually inspect parts, wirings, connector couplings, soldering and copper foils of the circuit board, which are suspect.
3. Check the action of the ascertained circuit by using a multimeter or test oscilloscope and refering the voltages and waveforms shown in the schematic diagram.
4. Finally, check suspect parts for the trouble by using a multimeter or curve tracer and replace the defective parts.

CIRCUIT BOARD REMOVAL

Preamplifier Unit

1. Disconnect four multi-connectors.
2. Desolder two shielded wire connections.

Fig. 5-5 Color coding of resistor and capacitor



Color	Resistance or capacitance value: 1st or 2nd significant digit	Multiplier	Tolerance for resistor	Tolerance for capacitor: Above 10pF	Below 10pF	Voltage rating for capacitor
BLK	0	1	–	±20.0	±2.0	–
BRN	1	10	±1	±1.0	–	–
RED	2	10^2	±2	±2.0	–	250V
ORG	3	10^3	–	±2.5	–	300V
YEL	4	10^4	–	–	–	–
GRN	5	10^5	–	±5.0	±0.5	500V
BLU	6	10^6	–	±100	–	–
VLT	7	10^7	–	–	–	–
GRY	8	10^8	–	±10.0	±0.25	–
WHT	9	10^9	–	–	±1.0	1000V
GOLD	–	10^{-1}	±5	–	–	–
SILVER	–	10^{-2}	±10	–	–	–
No color	–	–	±20	–	–	–

3. Loose four mounting screws of the board and the three screw which mount the unit to the front sub-panel on the top left, left and bottom left sides.
4. Pull out the unit together with the controls and the front panel of the vertical deflection system.

Switching Logic Board (PB550)

1. Remove the vertical preamp unit according to the previous instructions.
2. Disconnect the three multi-connectors mounted on the rear side of the board.
3. Loose one screw and two props.
4. Disconnect one multi-connector between this board and the sweep generator board.
5. Pull out the board backward.

Vertical Main Amp Board (PB1350)

1. Disconnect three pin-connections
2. Desolder the earth connection between the vertical main amp board and the shield case of the CRT.
3. Loose two mounting screws.
4. Gradually pull up the board and disconnect two multi-connectors.

Horizontal Amp Board (PB1400)

1. Disconnect four multi-connectors.
2. Disconnect two pin-connection.
3. Loose three mounting screws.

Trigger Generator Board (PB600)

1. Disconnect ten multi-connectors.
2. Loose four mounting screws.
3. Pull out the board backward.

Table 5-2 Diode electrode markings

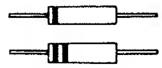
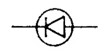
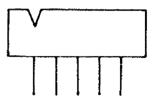
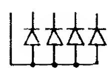
Type of diode	Electrode marking	Polarity
1S953 1S1924 1S955 1SS16 1S1544A 1N34A 1S1922D RD type		
V03C		
1S2191	 (Bottom view)	
1S 2200		
TLG103 TLR104	 (Bottom view)	
DAP-4		
DAN-4		

Table 5-3 Transistor elecrrode markings (bottom view)

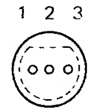
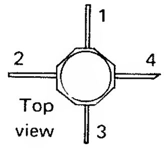
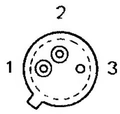
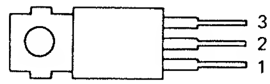
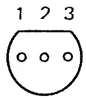
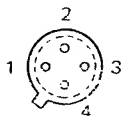
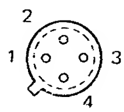
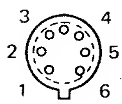
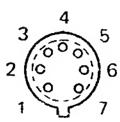
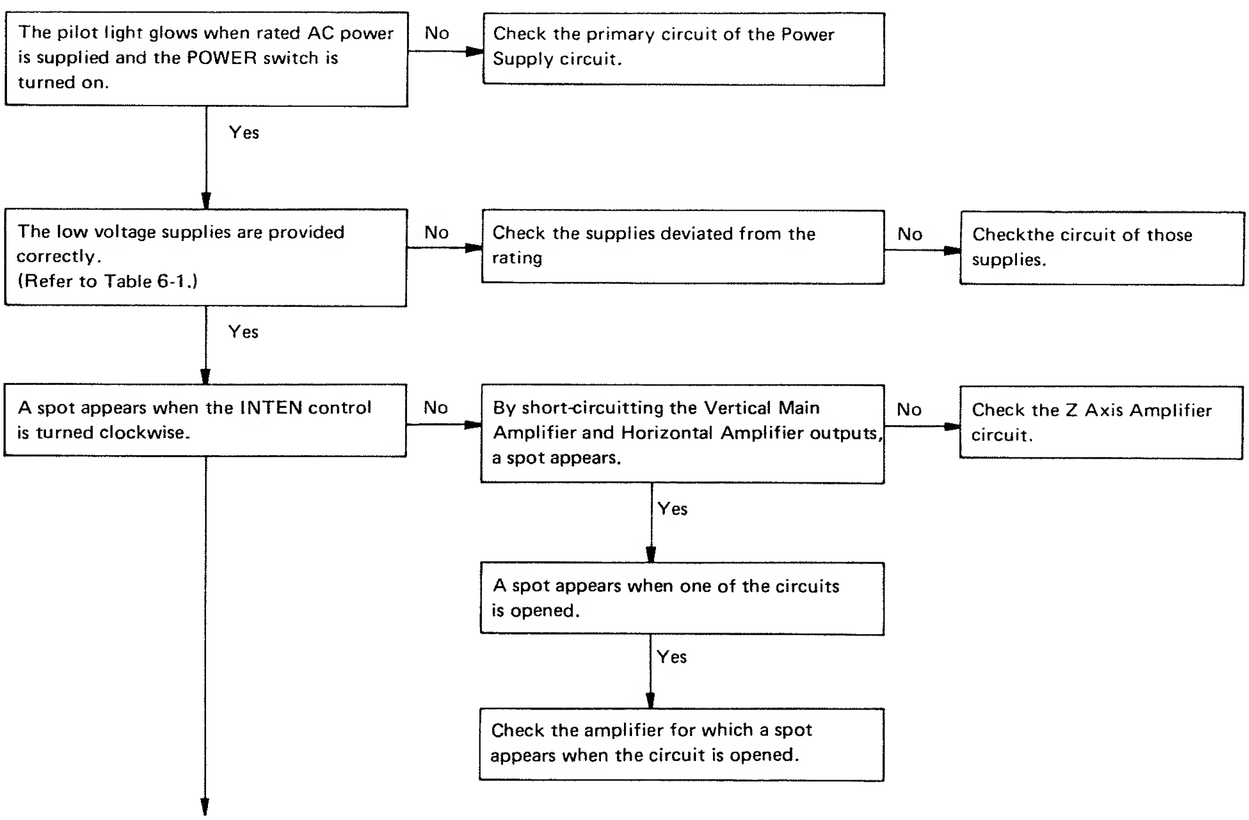
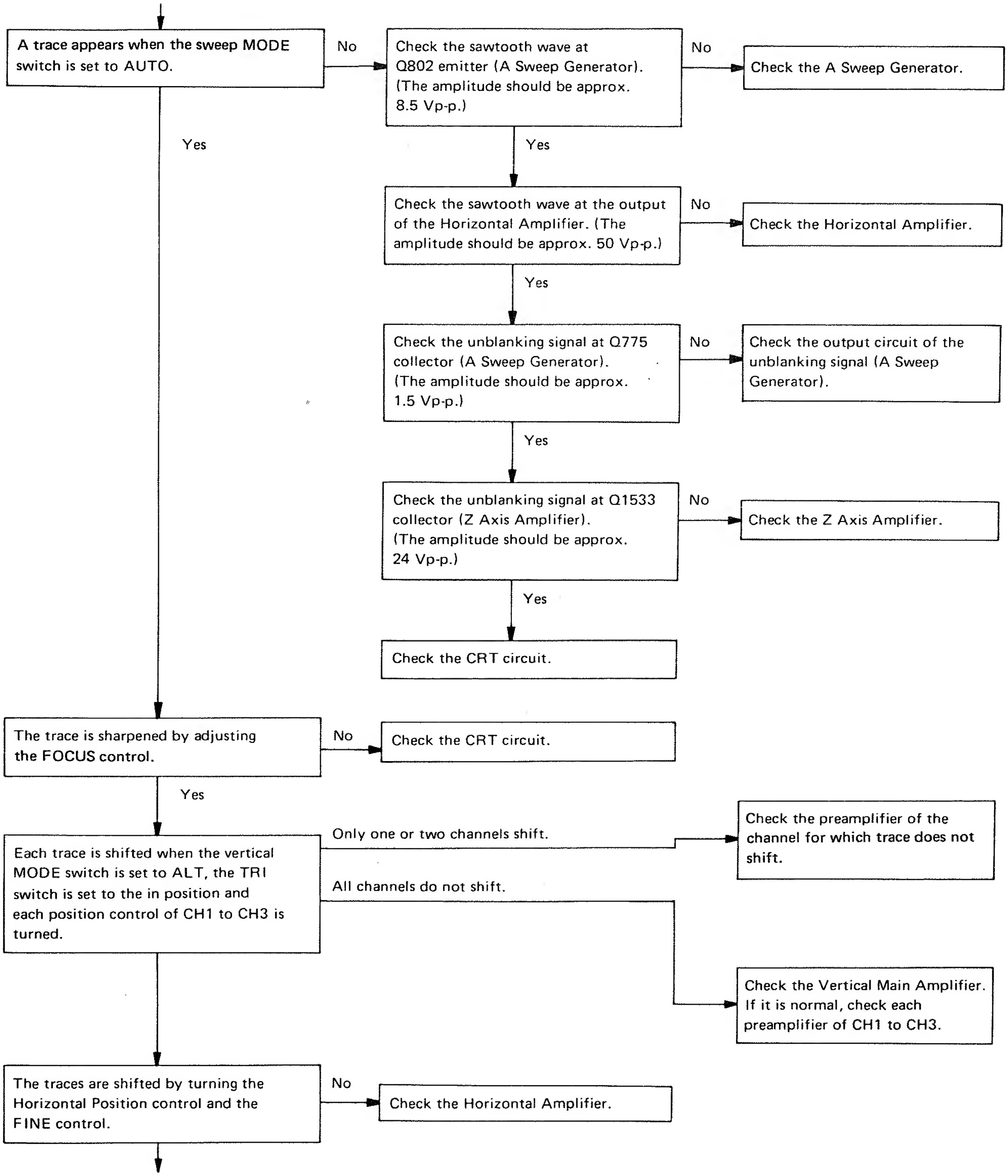
Type of transistor	Electrode marking	Type of transistor	Electrode marking
2SA495Y, O/Y 2SC373	 1. Emitter 2. Collector 3. Base	2SC2148	 1. Emitter 2. Collector 3. Emitter 4. Base
2SA578 2SC154C 2SA712 2SC1216 2SA810 2SC1217 2SA845A (H) 2SC1706 (H)	 1. Emitter 2. Base 3. Collector (case)	2SC1669 2SD288K 2SD560	 Top view 1. Base 2. Collector 3. Emitter
2N3905 2N5771	 1. Emitter 2. Base 3. Collector		
2SC1424 2SC1254	 1. Emitter 2. Base 3. Collector 4. Case		
30088C	 1. Source 2. Drain 3. Gate 4. Case		
2SC1733	 1. Emitter 2. Collector 3. Base 4. Base 5. Collector 6. Emitter		
2N5912	 1. Source 2. Drain 3. Gate 4. Case 5. Source 6. Drain 7. Gate		

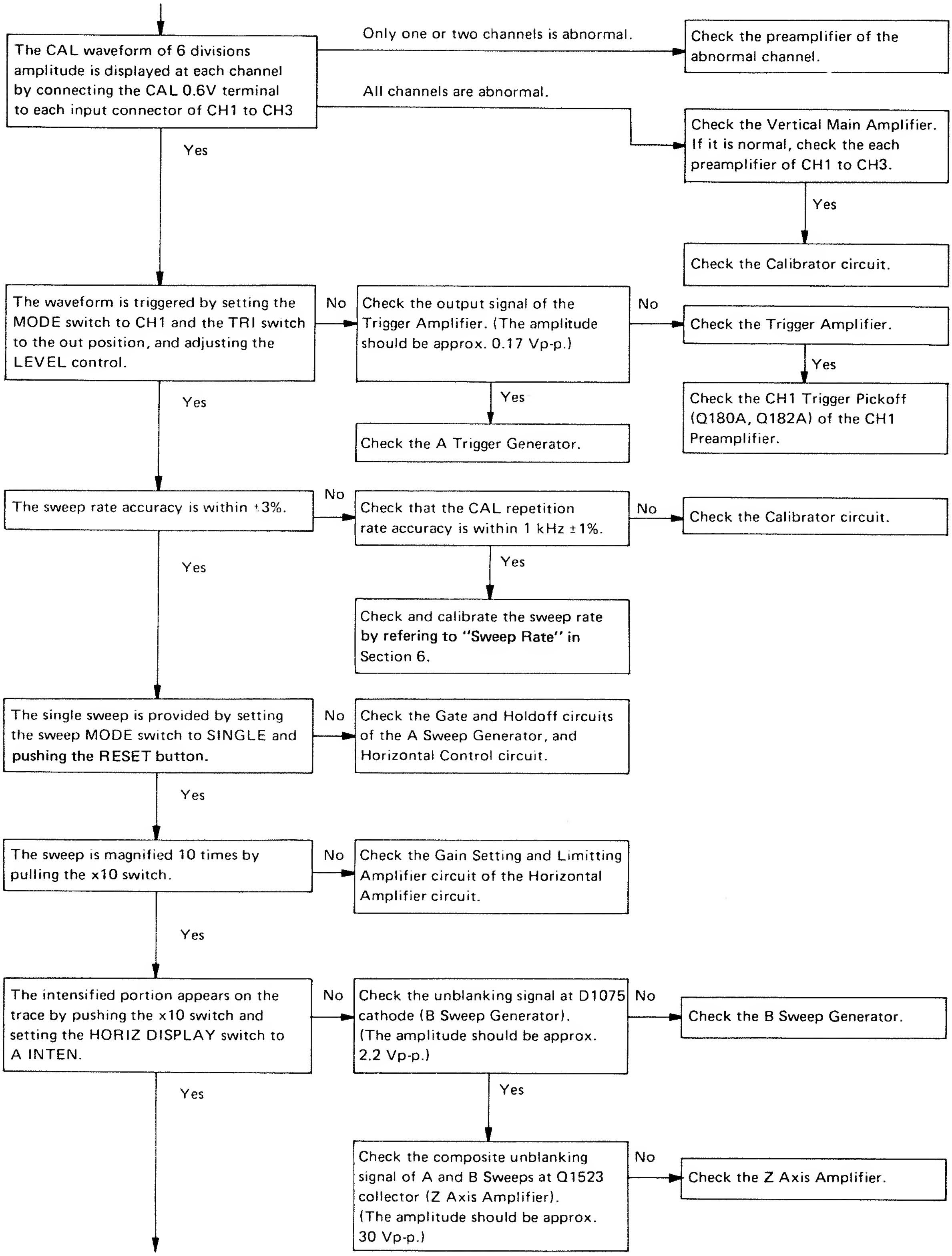
Fig. 5-6 Troubleshooting flow chart

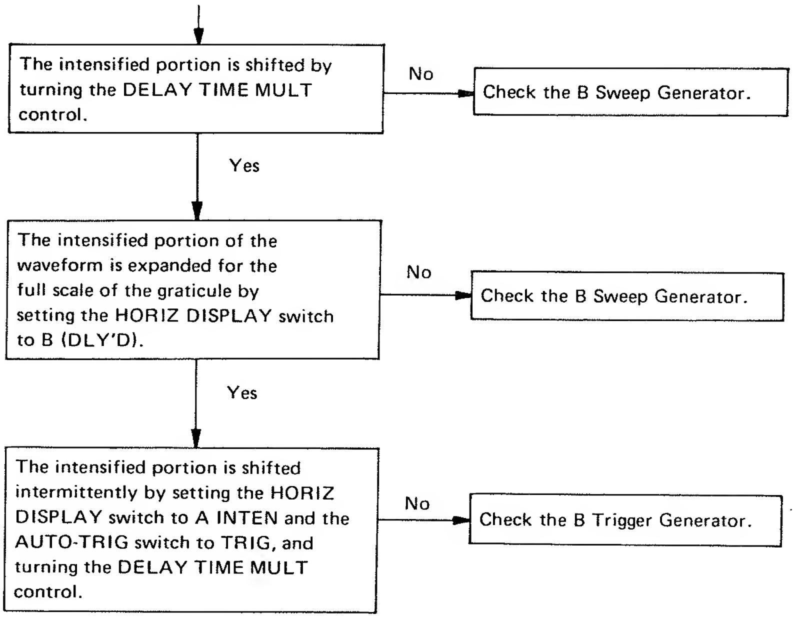
First, set the switches and controls as follows:

POWER	Off	LEVEL/SLOPE (A)	Push, Mid-position
INTEN	Mid-position	AC-HF REJ-DC	AC
FOCUS	Mid-position	INT-LINE	INT
SCALE	Fully clockwise	A TIME/DIV	1 mSEC
MODE (vertical)	CH1	B TIME/DIV	0.1 mSEC
TRI	Out	A VARIABLE	CALIB
CH2 POLAR	Out	HORIZ DISPLAY	A
TRIGGER	CH1	DELAY TIME MULT	Fully counterclockwise
BANDWIDTH	Out	AUTO-TRIG	AUTO
AC-GND-DC (CH1, CH2)	DC	AC-DC	AC
VOLTS/DIV (CH1, CH2)	10 mV	INT-EXT	INT
VARIABLE (CH1, CH2)	CALIB	LEVEL/SLOPE (B)	Push, Mid-position
POSITION (CH1, CH2)	Mid-position	HOLDOFF	Fully counterclockwise
CH3 POSITION	Mid-position	B Sweep Position	Mid-position
AC-DC	DC-0.1V	Horizontal Position	Mid-position
MODE (sweep)	NORM	FINE (PULL x10)	Push, Mid-position




A trace appears when the sweep MODE switch is set to AUTO.
No
Check the sawtooth wave at Q802 emitter (A Sweep Generator). (The amplitude should be approx. 8.5 Vp-p.)
No
Check the A Sweep Generator.
Yes
Yes
Check the sawtooth wave at the output of the Horizontal Amplifier. (The amplitude should be approx. 50 Vp-p.)
No
Check the Horizontal Amplifier.
Yes
Check the unblanking signal at Q775 collector (A Sweep Generator). (The amplitude should be approx. 1.5 Vp-p.)
No
Check the output circuit of the unblanking signal (A Sweep Generator).
Yes
Check the unblanking signal at Q1533 collector (Z Axis Amplifier). (The amplitude should be approx. 24 Vp-p.)
No
Check the Z Axis Amplifier.
Yes
Check the CRT circuit.
The trace is sharpened by adjusting the FOCUS control.
No
Check the CRT circuit.
Yes
Each trace is shifted when the vertical MODE switch is set to ALT, the TRI switch is set to the in position and each position control of CH1 to CH3 is turned.
Only one or two channels shift.
Check the preamplifier of the channel for which trace does not shift.
All channels do not shift.
Check the Vertical Main Amplifier. If it is normal, check each preamplifier of CH1 to CH3.
The traces are shifted by turning the Horizontal Position control and the FINE control.
No
Check the Horizontal Amplifier.


The CAL waveform of 6 divisions amplitude is displayed at each channel by connecting the CAL 0.6V terminal to each input connector of CH1 to CH3
Only one or two channels is abnormal.
Check the preamplifier of the abnormal channel.
All channels are abnormal.
Check the Vertical Main Amplifier. If it is normal, check the each preamplifier of CH1 to CH3.
Yes
Check the Calibrator circuit.
Yes
The waveform is triggered by setting the MODE switch to CH1 and the TRI switch to the out position, and adjusting the LEVEL control.
No
Check the output signal of the Trigger Amplifier. (The amplitude should be approx. 0.17 Vp-p.)
No
Check the Trigger Amplifier.
Yes
Check the CH1 Trigger Pickoff (Q180A, Q182A) of the CH1 Preamplifier.
Yes
Check the A Trigger Generator.
Yes
The sweep rate accuracy is within ±3%.
No
Check that the CAL repetition rate accuracy is within 1 kHz ±1%.
No
Check the Calibrator circuit.
Yes
Check and calibrate the sweep rate by refering to "Sweep Rate" in Section 6.
Yes
The single sweep is provided by setting the sweep MODE switch to SINGLE and pushing the RESET button.
No
Check the Gate and Holdoff circuits of the A Sweep Generator, and Horizontal Control circuit.
Yes
The sweep is magnified 10 times by pulling the x10 switch.
No
Check the Gain Setting and Limitting Amplifier circuit of the Horizontal Amplifier circuit.
Yes
The intensified portion appears on the trace by pushing the x10 switch and setting the HORIZ DISPLAY switch to A INTEN.
No
Check the unblanking signal at D1075 cathode (B Sweep Generator). (The amplitude should be approx. 2.2 Vp-p.)
No
Check the B Sweep Generator.
Yes
Check the composite unblanking signal of A and B Sweeps at Q1523 collector (Z Axis Amplifier). (The amplitude should be approx. 30 Vp-p.)
No
Check the Z Axis Amplifier.
Yes


The intensified portion is shifted by turning the DELAY TIME MULT control.
No
Check the B Sweep Generator.
Yes
The intensified portion of the waveform is expanded for the full scale of the graticule by setting the HORIZ DISPLAY switch to B (DLY'D).
No
Check the B Sweep Generator.
Yes
The intensified portion is shifted intermittently by setting the HORIZ DISPLAY switch to A INTEN and the AUTO-TRIG switch to TRIG, and turning the DELAY TIME MULT control.
No
Check the B Trigger Generator.

Timing Switch Board (PB1000)

1. Remove the trigger generator board according to the previous instructions.
2. Remove three knobs of the A VARIABLE control, B TIME/DIV switch and A TIME/DIV switch with the hexagonal wrench provided as an option.
3. Disconnect three multi-connectors and one pin-connector.
4. Loose four props.
5. Disconnect two multi-connectors between this board and the sweep generator board.

Sweep Generator Board (PB700)

1. Disconnect eleven multi-connectors mounted on the this board.
2. Take off the wire connections between this board and the trigger generator board by disconnecting two multi-connectors mounted on the trigger generator board.
3. Loose four mounting screws.
4. Loose one mounting screw between this board and the preamplifier board on the preamplifier board.

Power Supply Board (PB1800)

1. Disconnect eleven multi-connectors and two pin-connectors.
2. Take off four wire connections coated with silicon rubber by cutting off the silicon rubber and desoldering.
3. Loose four mounting screws.

PARTS REPLACEMENT

In this paragraph, the replacement procedures of defective parts are described.

When the replacement of the parts is required, be sure to disconnect the instrument from the power source.

Fuse Replacement

This instrument uses the fuses shown in Table 5-4 in order to prevent damage to the circuit due to overcurrent.

If these fuses are blown, check the cause, repair the defective parts or circuits, and exchange the blown fuse for the prescribed new ones. The use of a new fuse which is not prescribed may result in danger; therefore, such use is prohibited.

Table 5-4

Circuit No.	Type of Fuses	Function	Location
F1835	2 A slow-blow	Use this fuse when the Line Voltage Selector is set to A or B.	Rear panel
	1A slow-blow	Use when the Selector is set to C or D.	
F1840	1A slow-blow	Protection of CRT circuit	CRT circuit board

Parts on Printed Circuit Board

When replacing transistors, ICs, diodes, resistors or capacitors mounted on the printed circuit board, particular care must be exercised in the handling of the soldering iron so as not to peel the copper foil off or break parts.

The semiconductos are sensitive to heat. When desoldering or soldering, hold the semiconductor side of the wire lead being heated with pliers or tweezers to absorb the soldering heat. Complete soldering or desoldering quickly.

The semiconductors must be replaced with qualified ones. Some of transistors and diodes are specially selected to ensure the performance of this instrument. The selected type of transistors and diodes are given in Table 5-5. Refer to Tables 5-2 and 5-3 for identification of electrodes.

ICs are mounted with a socket or no socket (directly mounted). Pins of ordinary ICs are numbered as shown in Fig. 5-6 when the slot is positioned leftward. In special ICs made by IWATSU, pin No. 1 of A type is positioned at the deeply chamfered corner, and pin No. 1 of B type is positioned at the white dot. IWATSU ICs are not interchange-

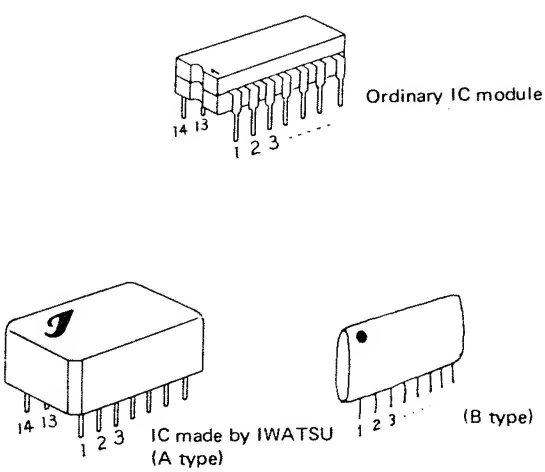
able with other models because of special design. In the case of directly mounted ICs, a dot or white number 1 is marked at the position on the printed circuit board to which pin 1 of IC is to be set.

Resistors, capacitors and other passive parts must be also replaced with new ones. Burning out of resistors or short circuitting of capacitors can occur incidentally with short-circuitting of semiconductors or excessive variations in the characteristics. Therefore, check and remove the cause of these defects before replacing the passive parts.

Table 5-5 List of specially selected transistors and diodes

Circuit	CKT. No. (type) of specially selected transistors and diodes
CH1 and CH2 PREAMPLIFIER (1)	D41A/B (1S1544A) Q40A/B (2N5912)
A SWEEP GENERATOR	Q801 (ITS30088C)
B TRIGGER GENERATOR	Q911/Q912 (ITS30088C)
B SWEEP GENERATOR	Q1086 (ITS30088C)

Fig. 5-6 Pin No. of IC



CRT

Dropping of or excessive shock to the CRT is very hazardous. Handle the CRT with special care.

Replace the CRT, when required, in the sequence given below;

1. Remove the top cover by removing six mounting screws.
2. Remove the rear panel by removing four feet.
3. Disconnect the socket from the CRT.
4. Disconnect seven pin-connections on the neck of the CRT.
5. Take off the wire connections of the trace rotation and arthogonality coils by disconnecting the connector mounted on the trigger generator board.
6. Remove the bezel.
7. Pull out the illumination plate inserted in the lower part of the CRT.
8. Gradually push out the CRT forward to find the connection of the accerelating electrode coated with silicon rubber.
9. Cut off the silicon rubber with a knife without cutting the a the cap connected to the accerelating electrode and disconnect the cap.

The CRT can be mounted in the reversed manner. When the CRT is replaced, the deflection factor and sweep rate must be calibrated.

HV Unit

1. Remove the shield case cover.
2. Loose one mounting screw and three props.
3. Disconnect one multi-connector and two pin-connectors on the HV unit.
4. Desolder four wirings on the HV unit.
5. Disconnect the cap connected to the accerelating electrode of the CRT according to the instructions above.

Power Transformer

1. Remove the rear panel by removing four feet.
2. Take off the wire connection between the transformer

and the power supply board by disconnecting the connector mounted on the power supply board.

3. Take off the wire connection between the transformer and the line voltage selector by desoldering on the terminals of the selector.
4. Take off front the power supply board by loosing the four mounting screws.
5. Loose four mounting screws of the transformer.

Power Transistor

The power transistors in the CRT and power supply circuits are mounted on the rear sub-panel with a insulation mylar film sheet inserted between the transistor and the sub-panel. Besides, the mylar sheet is coated with the silicon grease to improve the thermal condition. In case of replacement of these transistors, the mylar sheet coated with the silicon grease must be correctly inserted.

SECTION 6
PERFORMANCE CHECK AND CALIBRATION

Period of Check and Calibration

Since the performance of this instrument will vary with age, periodical check and calibration of the device is required.

If the instrument is used frequently, a check and calibration will be required after each 1000 hours, but the interval after the last check and calibration may be prolonged to 6 months, if not used so frequently.

Instrument Required for Check and Calibration

The following measuring instruments and accessories are required for a performance check and calibration of this instrument.

1. Digital voltmeter
   - Voltage range: 0 to 200V DC (direct)
     Accuracy: ±0.05% + 1 dgt
     0 to 3 kV DC (with high-voltage probe)
     Accuracy: ±5% + 1 dgt
     Example: IWATSU SC-7404
2. Oscilloscope
   - Deflection factor: 5mV/div or more
   - Frequency bandwidth: DC to 60 MHz
   - Cascade connection: Possible
     Example: IWATSU SS-5710
3. Scope calibrator — Example: IWATSU SC-340
4. Standard signal generator (I) (II)
   - Frequency range: (I) 50 kHz to 20 MHz
     (II) 10 MHz to 250 MHz
   - Output voltage: 60 mVp-p or more
     (The required output level accuracy must be maintained when the frequency is varied.)
     Example: GR Model 1026
5. Sine wave generator
   - Frequency range: 1 kHz to 20 kHz
   - Output voltage: 80 mVp-p or more
     Example: IWATSU FG-330
6. Pulse generator
   - Repetition rate: 50 to 100 kHz
   - Rise time: 0.35 ns or less
   - Waveform distortion: As small as possible
   - Output voltage: 60 mVp-p or more
     Example: HP Model 213B
7. Frequency counter
   - Frequency range: 500 Hz to 1.5 kHz
   - Resolution: 1 Hz
     Example: IWATSU FC-8841
8. 1:1 passive probe — Example: IWATSU Type SS-0001 ~ 0003
9. Voltage regulator
10. BNC coaxial cable — Example: IWATSU BB-120C
11. 10:1 passive probe (accessory)
12. BNC-T connector
13. 6 dB divider — Example: IWATSU B-50D3
14. 50Ω terminator — Two pieces
    Example: IWATSU BB-50M1
15. Non-inductive screwdriver — Example: Probe adjustment screwdriver, an accessory.

Notes:

1. The performance requirements shown above are the minimum requirements for testing the instruments concerned.
2. Signal input connector for this instrument is the BNC type. If the output connector of a terminator or another test instrument is not BNC type, a conversion connector must be prepared to connect the instrument directly to this oscilloscope.

Table for Check and Calibration Items

In this paragraph, the check and calibration items are

enumerated to show the interaction between the items. When the item having interaction with other items is calibrated, those items must be also calibrated. In addition, the check and calibration of the vertical deflection system must be performed in numerical order.

– Power Supply and CRT Circuits –

1. Low Voltage Power Supply
   (Interaction: All items)
2. Operating Voltage Range
3. Limitter Level
   (Interaction: 4)
4. CRT Cathode Voltage
   (Interaction: 5, 7, 16, 19, 21, 30, 31, 34)
5. Intensity
6. Parallelness of Vertical and Horizontal Traces to Graticule Line
7. Pattern Distortion

– Calibration Voltage Output –

8. Repetition Rate
9. Output Voltage

– Vertical Deflection System –

10. DC Balance
11. Gain Switching Balance
12. Variable Balance
13. Polarity Balance
14. ADD Trace Position
15. Position Centering
16. Deflection Factor
    (Interaction: 10, 11, 12, 13, 34)
17. Pulse Response
    (Interaction: 18)
18. Frequency Response
19. Linearity
20. Attenuator Phase
21. Channel 3
22. Cascade Connection

– Triggering –

23. A Trigger Bias
24. Level Centering of A Triggering
25. Level Centering of B Triggering

– Sweep –

26. Jitterless Circuit
27. Operation of B Sweep
28. Start Point of A Sweep
    (Interaction: 32)
29. Magnifier Centering
30. Sweep Rate
    (Interaction: 31, 32)
31. Sweep Rate at Magnified Sweep
32. Delay Time
33. Delay Jitter

– X-Y Operation –

34. Spot Position
35. Deflection Factor
36. Phase Difference

Precautions

The following precautions must be observed before checking and calibrating the performance of this instrument:

1. It is assumed, in this section, that the setting of controls is made in the position described in the section "Preparation". Therefore, the controls must be set to the position given in "Preparation", prior to starting check and calibration of all items or limited to partial ones.
2. Signal outputs of signal generators must be terminated with the rated output impedance (terminator).
3. Since the low power supply voltages are commonly supplied to all circuits, excessive increase in the ripples and voltage error will affect the performance of the circuits. Be sure to check the power supplies before starting the check and calibration of the circuit performance.
4. If a circuit does not operate as described, or it does not satisfy the rated performance, troubleshooting is required as given in the section "Maintenance." Repeat calibration of the circuit, after repaired.

Preparation

Be sure to complete the preparation given below before starting the check and calibration.

1. Adjust the ambient temperature within 10°C to 35°C.
2. Set controls as given below before supplying the power to the instrument.

POWER	Off
INTEN	Mid-position
FOCUS	Mid-position
SCALE	Fully clockwise
MODE (vertical)	CH1
TRI	In
CH2 POLAR	Out
TRIGGER	CH1
BANDWIDTH	Out
AC-GND-DC(CH1,CH2)	DC
VOLTS/DIV(CH1,CH2)	10 mV
VARIABLE(CH1,CH2)	CALIB
POSITION(CH1,CH2)	Mid-position
CH3 POSITION	Mid-position
AC-DC	DC-0.1V
MODE (sweep)	AUTO
LEVEL/SLOPE(A)	Push, Mid-position
AC-HF REJ-DC	AC
INT-LINE	INT
A TIME/DIV	1 mSEC
B TIME/DIV	10 nSEC
A VARIABLE	CALIB
HORIZ DISPLAY	A
DELAY TIME MULT	Fully counterclockwise
AUTO-TRIG	AUTO
AC-DC	AC
INT-EXT	INT
LEVEL/SLOPE(B)	Push, Mid-position
HOLDOFF	Fully counterclockwise
B Sweep Position	Mid-position
Horizontal Position	Mid-position
FINE (PULL x10)	Push, Mid-position

3. Set the Line Voltage Selector located on the rear panel to a connection matched to your line voltage. Connect the power cord on the line receptacle. If the line voltage is out of the voltage range to be covered by the selector, use the voltage regulator to adjust the power supply voltage.
4. Turn the POWER switch on, adjust the intensity of the traces and allow the instrument to warm up for about 1 hour.
5. Pull the TRI switch out.

— Power Supply and CRT Circuits —

Low Voltage Power Supply

Rating

Output DC voltages and ripple components must be within the range shown in Table 6-1.

Table 6-1

Nominal voltage	Output voltage accuracy	Ripple voltage	Calibration control
−12V	Within ±0.12V	1 mVp-p or less	R1878
+ 5V	Within ±0.2 V	1 mVp-p or less	—
+ 12V	Within ±0.2 V	1 mVp-p or less	—
+ 40V	Within ±1.0 V	1 mVp-p or less	—
+150V	Within ±5.0 V	5 mVp-p or less	—

Check and Calibration

1. Connect a digital voltmeter between each test point shown in Fig. 6-1 and the chassis, and check if the output voltages are within the range given in Table 6-1.
2. If the supply voltages are out of the rating, calibrate −12V circuit by R1878 −12V ADJ (see Fig. 6-1), and check other output voltages (the Power Supply circuit is designed so that other voltage outputs are in the rated range by no calibration when the calibration of −12V supply is completed).
3. Set the sweep MODE switch to SINGLE to stop the sweep.
4. Check the amplitude of ripple component of each DC line by using a test oscilloscope. Increase the vertical deflection factor of the test oscilloscope to 1 mV/div, with the cascade connection.

Operating Voltage Range

Rating

The display must be sufficiently stable against variation in the operating voltages given in Table 6-2.

Table 6-2

Line voltage selector	Center voltage	Voltage range	Fuse
A	110V AC	90 ~ 110V	2A Slow
B	117V AC	160 ~ 128V	
C	217V AC	196 ~ 238V	1A Slow
D	234V AC	211 ~ 257V	

Check

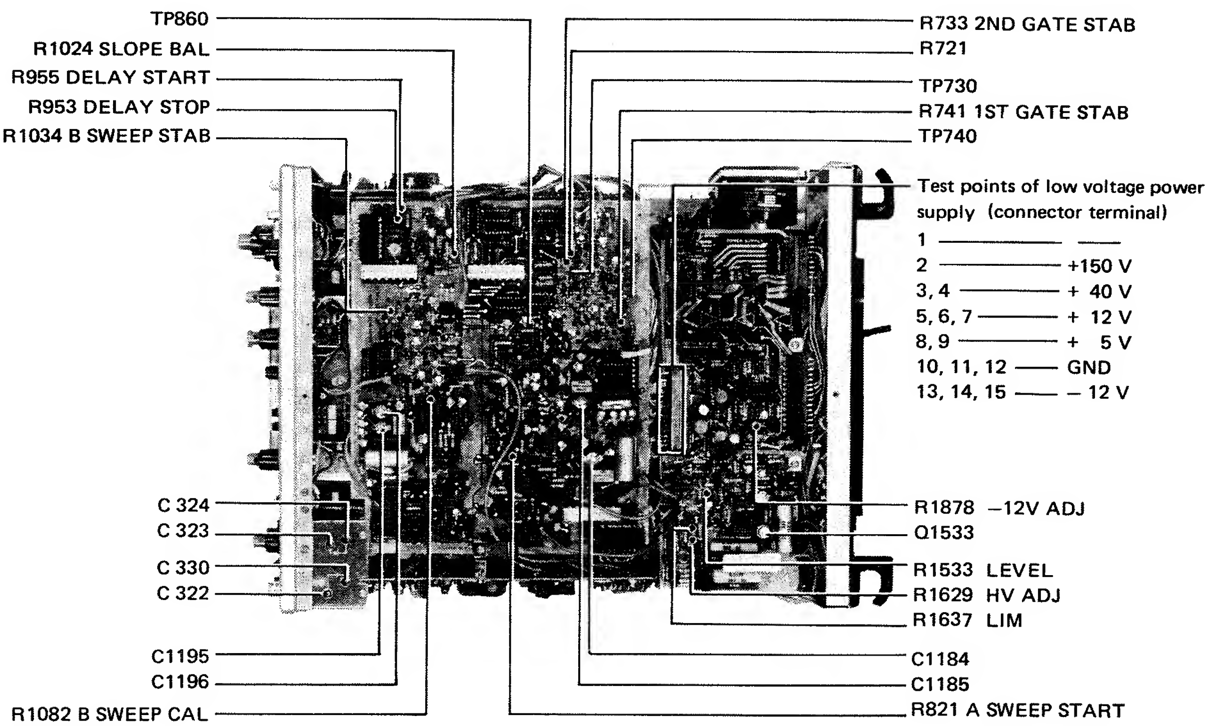
1. Turn the POWER switch off and disconnect the power cord from the line receptacle. Connect the power cord to the line through a voltage regulator (slide auto transformer), and set the regulator output voltage to the rated center voltage (see Table 6-2).
2. Turn the POWER switch on an connect the CAL 0.6V terminal to the input connector using the accessory probe. The signal amplitude should be 6 divisions.
3. Set the A TIME/DIV switch to 10 mSEC.
4. Vary the regulator output voltage continuously within the rated voltage range. Neither ripple nor intensity modulation should appear in the display.

Limiter Level

Rating

The limiter must operate, when the CRT cathode voltage (−2450V) is increased to −2750V or more, to repeat oscillation and when there is no oscillation of the

Fig. 6-1 Calibration controls and test points (bottom)



CRT circuit for approximately a 1 second period. The limiter must be reset when the CRT cathode voltage is returned to normal voltage.

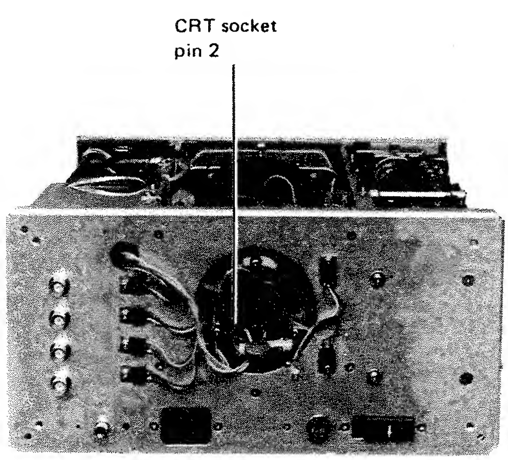
Note: The limiter protects the CRT from irregular increase of the CRT cathode voltage. Excepting when the limiter does not operate normally, or when the calibration of the CRT cathode voltage is required, the check of the limiter must not be done, because, the checking of the limiter operating level requires adjusting of the CRT cathode voltage which, if erroneously reset, may change the deflection sensitivity of the CRT.

Caution: Be careful to protect your body from the electric shock when checking or calibrating the limiter level and the CRT cathode voltage (described later). Also, be sure to turn off the trace when checking these circuits, by rotating the INTEN control fully counterclockwise.

Calibration

1. Rotate R1637 LIM (see Fig. 6-1) fully clockwise.
2. Connect a digital voltmeter (with a high voltage probe) between the CRT cathode test point (pin 2 of the CRT socket, see Fig. 6-2) and the chassis. Set the CRT cathode voltage to –2750V by adjusting R1629 HV ADJ (see Fig. 6-1).
3. Gradually rotate R1673 LIM counterclockwise and set it to the position at which the limiter operates, ie., the trace intensity varies intermittently.
4. Calibrate the CRT cathode voltage by the procedure given in the following "CRT Cathode Voltage".

Fig. 6-2 Test point of CRT cathode voltage



CRT Cathode Voltage

Rating

The CRT cathode voltage with respect to the ground must be within –2450V ±5%.

Note: If the CRT cathode voltage is not exactly –2450V, but within the rating (±5%), calibration of this voltage is not required excepting the following cases.

1. Overall calibration of all items.
2. Calibration of the deflection factor and the sweep rate.

Check and Calibration

1. Check that the CRT cathode voltage is within –2450V ±5%, by connecting a digital voltmeter (with a high voltage probe) between pin 2 of the CRT socket (see Fig. 6-2) and chassis.
2. If the voltage is out of the rating, adjust R1629 HV ADJ (see Fig. 6-1).

Intensity

Rating

A spot must appear when the INTEN control is rotated fully clockwise, and the trace must disappear when the control is rotated fully counterclockwise.

Check and Calibration

1. Set the sweep MODE switch to SINGLE to stop the sweep.
2. Rotate the INTEN control fully clockwise and check that a spot is visible on the CRT.
3. Start the sweep by setting the sweep MODE switch to AUTO.
4. Rotate the INTEN control fully counterclockwise and check that the trace disappears.
5. If above checks reveal unsatisfactory results adjust the intensity as follows.

6. Set the sweep MODE switch to SINGLE and rotate the INTEN control fully clockwise.
7. Connect a digital voltmeter between the output of the Z axis amplifier (Q1533 collector, see Fig. 6-1) and chassis, and adjust the voltage to +30V by R1513 LEVEL (see Fig. 6-1).
8. Adjust R1601 INTEN ADJ (see Fig. 6-3) so that a spot is visible on the CRT.

Parallelness of Vertical and Horizontal Traces to Graticule Lines

Rating

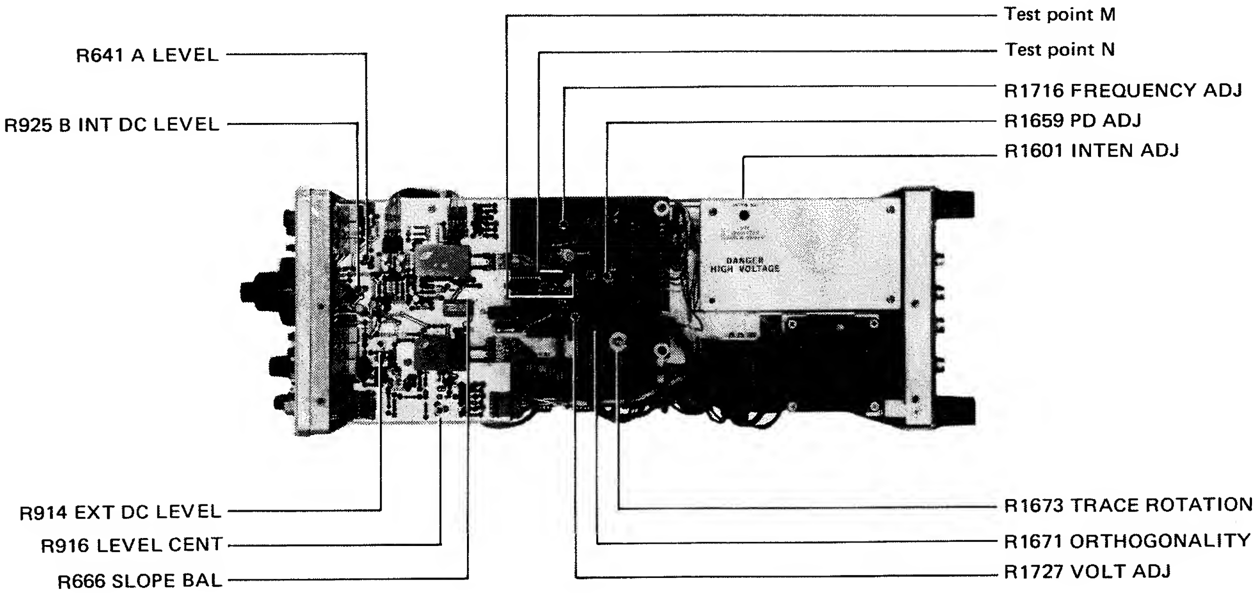
The vertical and horizontal traces must be parallel to the vertical and horizontal graticule lines.

Notes: As the parallelness of the traces to a scale line is somewhat affected by the earth magnetism, check and calibrate the instrument in the actually used position.

Check and Calibration

1. Adjust the vertical POSITION control to see the trace on the horizontal center line of the graticule and check parallelness of the trace to the line.
2. If the trace is not exactly parallel to the center line, adjust R1673 TRACE ROTATION (see Fig. 6-3).
3. Connect the signal of a sine wave generator to the CH1 input connector, and set the displayed amplitude to larger than 8 divisions.
4. Set the sweep MODE switch to SINGLE to stop the sweep, and adjust the INTEN control until a vertical trace appears.

Fig. 6-3 Calibration controls and test points (right side)



5. Adjust the Horizontal Position control to set the trace on the vertical center line of the graticule, and check the parallelness of the trace to the line.
6. If the trace is not parallel to the vertical center line, adjust R1671 ORTHOGONALITY (see Fig. 6-3).
7. Since the adjustments 2 and 6 have some correlation, repeat these adjustments until the correct parallelness is obtained in both vertical and horizontal directions.

Pattern Distortion

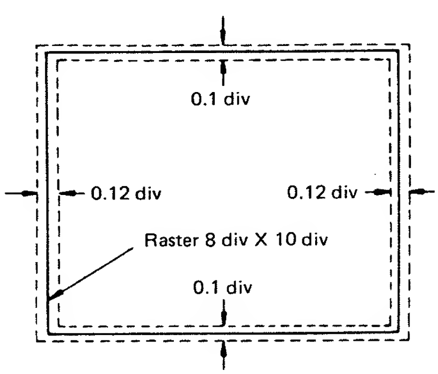
Rating

When a raster is fully displayed in the 8 divisions (V) by 10 divisions (H) area, the sides of the raster must be straight not exceeding the limit 0.12 division (vertical) and 0.1 division (horizontal) as shown in Fig. 6-4.

Check and Calibration

1. Connect the sine wave generator signal to the CH1 input connector.
2. Adjust the signal output level to set the displayed amplitude to 8 divisions.
3. Set the signal frequency to approximately 20 kHz and the A TIME/DIV switch to 1 mSEC so that a raster may be displayed.
4. Check the curvature of the upper and lower ends of the raster from the horizontal scale.
5. Adjust the Horizontal Position control to set the vertical ends of the raster with the left or the right ends of the vertical scale, and check the curvature of the raster from the scale line.
6. If the curvature of the raster from the scale lines exceeds the rating, adjust R1659 PD ADJ (see Fig. 6-3) to reduce the pattern distortion to a minimum.

Fig. 6-4 Pattern distortion



— Calibration Voltage Output —

Repetition Rate

Rating

1 kHz ±1%

Check and Calibration

1. Switch off the power and short between M and N (see Fig. 6-3) of the test point using a suitable wire.
2. Set the resolution of the counter to 1 Hz and count the frequency (repetition rate) of the calibration voltage output.
3. Check if the displayed value of the counter is within from 990 to 1010 Hz.
4. If it is out of the rating, adjust R1716 FREQUENCY ADJ (see Fig. 6-3).

Output Voltage

Rating

0.6V ±1%

Check and Calibration

1. Switch off the power and short between M and N of the test point using a suitable wire.
2. Switch on the power.
3. Connect a digital voltmeter between the CAL 0.6V terminal and chassis, and check if the displayed value is within from 0.594 to 0.606V.
4. If it is out of the rating, adjust R1727 VOLT ADJ (see Fig. 6-3).

DC Balance

Check and Calibration

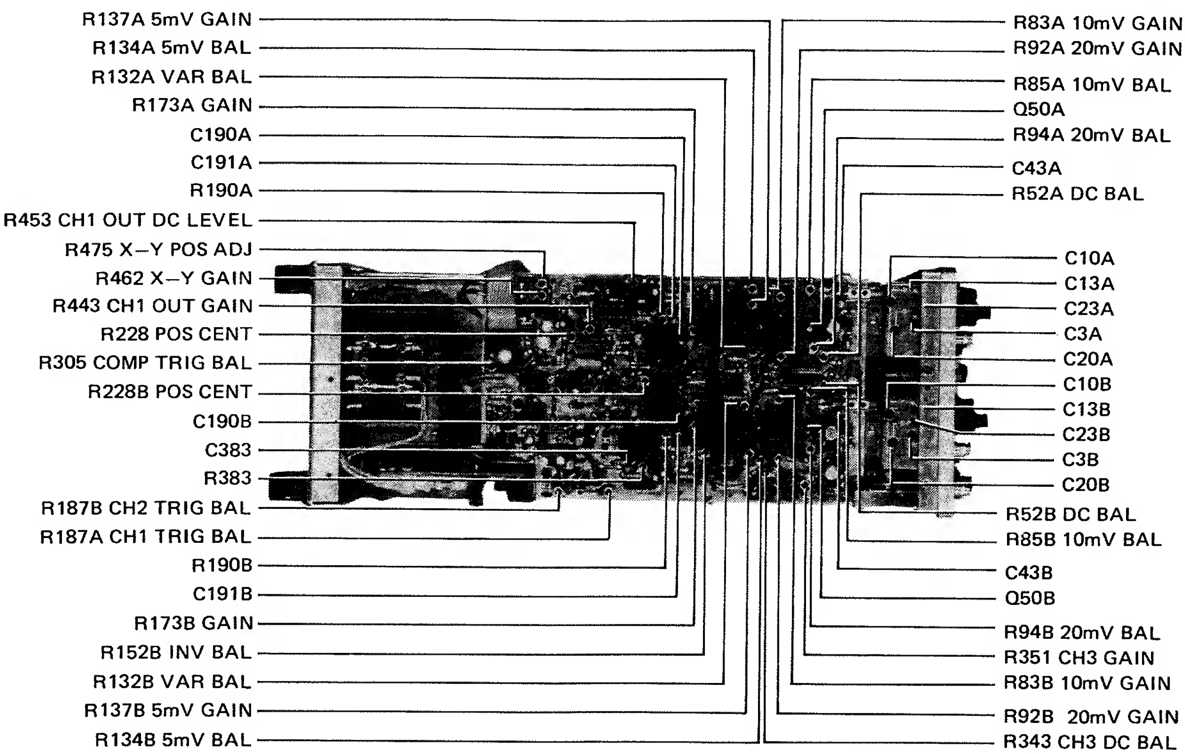
1. Set the AC-GND-DC switches of CH1 and CH2 to GND.
2. Set the VOLTS/DIV switches of CH1 and CH2 to 50 mV.
3. Connect a digital voltmeter between emitters of Q50A/Q50B (dual-transistor, see Fig. 6-5) and check if each voltage difference is within 5 mV.
4. If the difference is out of the rating, adjust R52A (CH1)/R52B(CH2) DC BAL (see Fig. 6-5).

Gain Switching Balance

Check and Calibration

1. Set the vertical MODE switch ALT.
2. Rotate the VOLTS/DIV switches of CH1 and CH2 from 50 mV to 20 mV and check if each trace shifts vertically.
3. If the traces shift, adjust R94A(CH1)/R94B(CH2) 20mV BAL (see Fig. 6-5).
4. Rotate the VOLTS/DIV switches of CH1 and CH2 from 20mV to 10mV, and check if each trace shifts.
5. If the traces shift, adjust R85A(CH1)/R85B(CH2) 10mV BAL (see Fig. 6-5).

Fig. 6-5 Calibration controls (left side)



Variable Balance

Check and Calibration

1. Set the vertical MODE switch to ALT.
2. Rotate the VARIABLE controls of CH1 and CH2, and check if each trace shifts vertically.
3. If the traces shift, adjust R132A(CH1)/R132B(CH2) VAR BAL (see Fig. 6-5).

Polarity Balance

Check and Calibration

1. Set the vertical MODE switch to CH2.
2. Repeat the in-out switching of the CH2 POLAR switch and check if the trace shifts vertically.
3. If the trace shifts, adjust R152B INV BAL (see Fig. 6-5).

ADD Trace Position

Check and Calibration

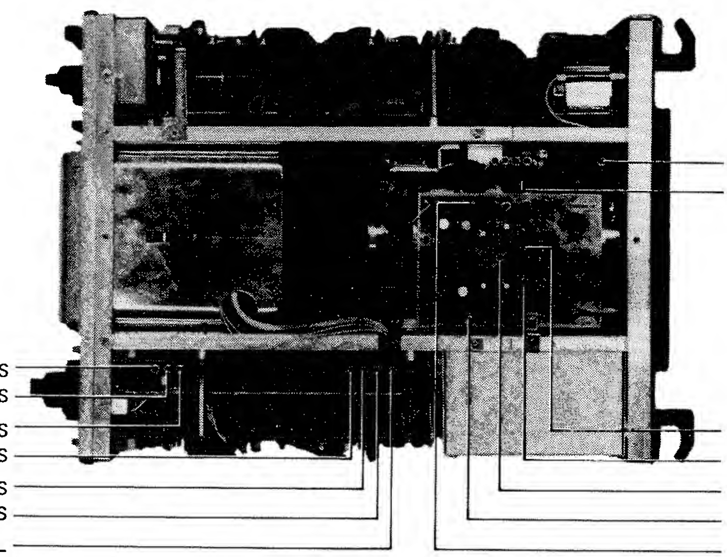
1. Set the vertical MODE switch to ALT.
2. Set both trace positions of CH1 and CH2 to the vertical center of the CRT.
3. Set the vertical MODE switch to ADD and check if the trace is set to the center of the CRT.
4. If the trace deviates from the center, adjust R1312 DC BAL (see Fig. 6-6).

Position Centering

Check and Calibration

1. Set the vertical MODE switch to ALT.
2. Set the POSITION controls of CH1 and CH2 to the mid-position, and check if each trace position is set to the center of the CRT.
3. If the positions deviate from the center, adjust R228A (CH1)/R228B(CH2) POS CENT (see Fig. 6-5).

Fig. 6-6 Calibration controls (top)



Deflection Factor

Rating

±2%

Check

1. Set the controls of CH1 and CH2 as follows:

VOLTS/DIV	5mV
VARIABLE	CALIB
AC-GND-DC	DC

2. Connect the OUTPUT 2 connector of the scope calibrator, SC-340 to the signal input connector.
3. Set the controls of the SC-340 as follows:

SQUARE WAVE 1	Push
AMPLITUDE	20mV

4. Set the display to the center of the graticule area and check if the displayed amplitude is within 4 divisions ±2%.
5. Check the accuracy of each deflection factor by rotating the VOLTS/DIV and AMPLITUDE switches as shown Table 6-3.

Table 6-3

Setting of VOLTS/DIV	Setting of AMPLITUDE	Displayed amplitude
5 mV	20 mV	4 div. ±2%
10 mV	50 mV	5 div. ±2%
20 mV	100 mV	5 div. ±2%
50 mV	200 mV	4 div. ±2%
0.1 V	0.5 V	5 div. ±2%
0.2 V	1 V	5 div. ±2%
0.5 V	2 V	4 div. ±2%
1 V	5 V	5 div. ±2%
2 V	10 V	5 div. ±2%
5 V	20 V	4 div. ±2%

Calibration

1. Calibrate the error at 50mV by R173A(CH1)/R173B (CH2) GAIN (see Fig. 6-5).
2. Calibrate the error at 20mV by R92A(CH1)/R92B(CH2) 20mV GAIN (see Fig. 6-5).
3. Calibrate the error at 10mV by R83A(CH1)/R83B(CH2) 10mV GAIN (see Fig. 6-5).
4. Calibrate the error at 5 mV by R137A (CH1)/R137B (CH2) 5mV GAIN (see Fig. 6-5).

Note: The Vertical Deflection System is designed so that the accuracy of each range from 0.1 to 5V is within the rated range with no calibration when the calibration of items from 1 to 4 is completed.

Pulse Response

Rating

Overshoot:	8% or less
Sag (at 1 kHz):	1% or less
Other distortion:	5% or less

(at 10mV range, refer to Figs. 6-7 and 6-8.)

Check and Calibration

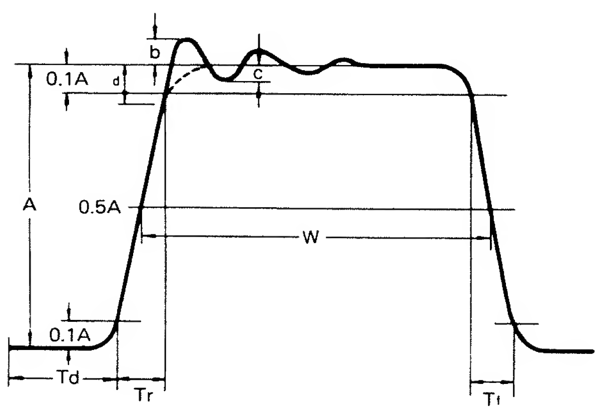
1. Set the controls of CH1 and CH2 as follows:

VOLTS/DIV	10mV
VARIABLE	CALIB
AC-GND-DC	DC

2. Connect the OUTPUT 3 connector of the scope calibrator, SC-340 to the signal input connector.
3. Set the controls of the SC-340 as follows:

SQUARE WAVE 2	Push

Fig. 6-7 Definition of pulse terms (by MEA-27, Japanese Electric Machinery Industry Association)



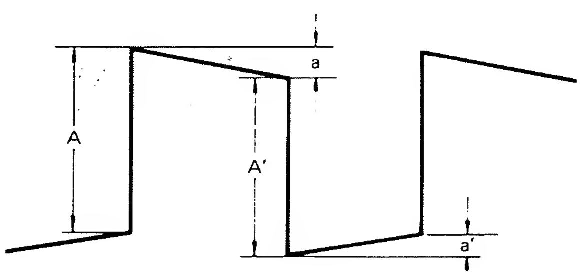
A	:	Basic amplitude	T	:	Rise time
b/A	:	Overshoot	Tf	:	Fall time
c/A	:	Ringing	d/A	:	Rounding
W	:	Pulsewidth	Td	:	Signal delay time

REPETITION	1 kHz
AMPL	Adjust to set the displayed amplitude to 6 divisions.

4. Set the display to the center of the CRT and check the sag.
5. Connect the pulse output of a pulse generator to the signal input connector.
6. Adjust the pulse output voltage to set the displayed amplitude to 6 divisions, rotate the A TIME/DIV switch to display the whole of one pulse in the viewing area, and check the overshoot and the other distortion.
7. If the distortion exceeds the rating, adjust the following calibration controls:
   (Note that these controls must be adjusted so that the rising edge of the waveform can rise as sharply as possible while minimizing overshoot, otherwise, frequency response will be affected.)
   Common to CH1 and CH2: C1360 (see Fig. 6-6)
   For CH1: C190A, C191A, R190A (see Fig. 6-5)
   For CH2: C190B, C191B, R190B (see Fig. 6-5)

Note: When the above-mentioned adjustment is performed, the frequency response must be checked with the procedure explained in the following item, Frequency Response.

Fig. 6-8 Sag waveform (by MEA-27, Japanese Electric Machinery Industry Association)



A : Basic amplitude
a : Sag

Sag = a/A (or a'/A', whichever larger) x 100%

Frequency Response

Rating

5mV/div:	DC to 200 MHz −3 dB
10 mV/div :	DC to 275 MHz −3 dB
20 mV/div to 5 V/div:	DC to 275 MHz −3.5 dB

Check

1. Set the controls of CH1 and CH2 as follows:

VOLTS/DIV	5mV
VARIABLE	CALIB
AC-GND-DC	DC

2. Connect the signal of a standard signal generator (II) to the signal input connector.
3. Set the signal frequency to 10 MHz and adjust the signal output level to set the displayed amplitude to 6 divisions.
4. Set the display to the center 6 divisions of the CRT.
5. Set the frequency to 200 MHz and check if the amplitude is more than 4.25 divisions (−3 dB referred to 6 divisions).
6. Set the VOLTS/DIV switch to 10mV, set the signal frequency to 10 MHz and adjust the signal output level to set the displayed amplitude to 6 divisions.
7. Set the frequency to 275 MHz and check if the amplitude is more than 4.25 divisions.
8. Set the VOLTS/DIV switch to 20 mV, set the frequency to 10 MHz and adjust the output level to set the displayed amplitude to 6 divisions.
9. Set the frequency to 275 MHz and check if the amplitude is more than 4.00 divisions (−3.5 dB referred to 6 divisions).

Note: If the frequency response is poorer than the rating, adjust the Pulse Response.

Linearity

Rating

±4% (at 1 kHz)

Check

1. Connect the OUTPUT 2 connector of the scope calibrator, SC-340 to the signal input connector, and push the SINE WAVE ≒ 1 kHz button.
2. Display the 2 divisions amplitude of the signal to the center 2 divisions of the CRT by the VOLTS/DIV switch and the VARIABLE control.
3. **Shift the waveform to the upper/lower part of the graticule unit the top/bottom of the waveform reaches the end of the graticule, and check that the variation of the displayed amplitude is within 0.08 division.**

Attenuator Phase

Rating

±1%

Check

1. Set the controls of CH1 and CH2 as follows:

VOLTS/DIV	10mV
VARIABLE	CALIB
AC-GND-DC	DC
A TIME/DIV	0.5 mSEC

2. Connect the accessory 10:1 probe between the signal input connector and the OUTPUT 2 connector of the scope calibrator, SC-340.
3. Set the controls of the SC-340 as follows:

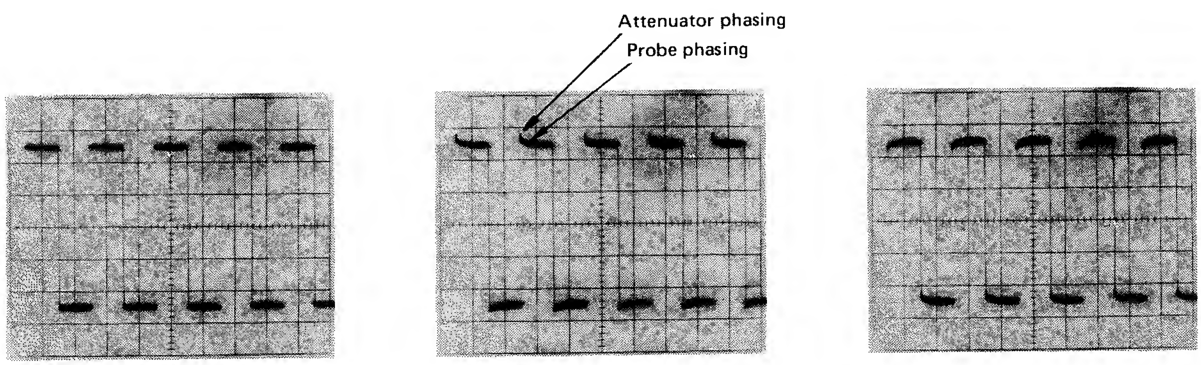
SQUARE WAVE 1	Push
AMPLITUDE	0.5V

4. As the above-mentioned operation allows 5 divisions amplitude of the signal on the CRT, adjust the phasing capacitor of the probe so that the correct phasing can be obtained and check if the adequate Attenuator Phasing is given. (see Fig. 6-9) If incorrect phasing is given in the Attenuator Phasing, adjust C43A (see Fig. 6-5).
5. Set the VOLTS/DIV and AMPLITUDE switches to 20mV and 1V respectively and check if the correct phasing is given in the Attenuator Phasing and Probe Phasing.
6. Similarly, check the phase at each setting of the VOLTS/DIV switch.

Calibration

Adjust the variable capacitors shown in Table 6-4.

Fig. 6-9 Attenuator phase and probe phase



(a) Correct phasing (b) Incorrect (over-compensation) (c) Incorrect (poor compensation)

Attenuator phasing : Phase of the small-time-constant portion.
Probe phasing : Phase of the large-time-constant portion.

Table 6-4

VOLTS/DIV	Variable Capacitor	
	For Attenuator Phasing	For Probe Phasing
5 to 50 mV	C43A/B	C 3A/B
0.1 to 0.5 V	C10A/B	C13A/B
1 to 5 V	C20A/B	C23A/B

Note: A: CH1, B: CH2

Channel 3

1. Deflection Factor

Rating

±3%

Check and Calibration

1. Set the controls as follows:

TRI	In
MODE (vertical)	ALT
AC-DC(CH3)	DC-0.1V
TRIGGER	CH3

2. Connect the OUTPUT 2 connector of the scope calibrator, SC-340, to the CH3 input connector.
3. Set the controls of the SC-340 as follows:

SQUARE WAVE 1	Push
AMPLITUDE	0.5V

4. Set the display to the center of the CRT and check if the displayed amplitude is within 5 divisions ±3%.
5. If the amplitude is out of the rating, adjust R351 CH3 GAIN (see Fig. 6-5).
6. Set the AC-DC switch to DC-1V.
7. Set the AMPLITUDE switch to 5V and check if the displayed amplitude is within 5 divisions ±3%.

2. Pulse Response

Rating

Overshoot:	7% or less
Sag:	2% or less
Other distortion:	5.5% or less

(At 0.1V range, refer to Figs. 6-7 and 6-8).

Check and Calibration

1. Set the controls as follows:

TRI	In
MODE (vertical)	ALT
AC-DC (CH3)	DC-0.1V
TRIGGER	CH3

2. Connect the OUTPUT 3 connector of the scope calibrator, SC-340 to the CH3 input connector.
3. Set the controls of the SC-340 as follows:

SQUARE WAVE 2	Push
REPETITION	1 kHz
AMPL	Adjust to set the displayed amplitude to 6 divisions.

4. Set the display to the center of the CRT and check the sag.
5. Connect the pulse output of a pulse generator to the CH3 input connector.
6. Adjust the pulse output voltage to set the displayed amplitude to 6 divisions, rotate the A TIME/DIV switch to display the whole of one pulse in the viewing area, and check the overshoot and the other distortion.
7. If the distortion exceeds the rating, adjust C383 and R383 (see Fig. 6-5). Note that these controls must be adjusted so that the rising edge of the waveform can rise as sharply as possible while minimizing overshoot, otherwise, frequency response will be affected.

3. Frequency Response

Rating

0.1V/div:	DC to 200 MHz –3 dB
1V/div:	DC to 200 MHz –3.5 dB

Check

1. Set the controls as follows:

TRI	In
AC-DC (CH3)	DC-0.1V
TRIGGER	CH3

2. Connect the signal of a standard signal generator (II) to the CH3 input connector.
3. Adjust the signal frequency to 10 MHz and adjust the signal output voltage to set the displayed amplitude to 6 divisions.
4. Adjust the signal frequency to 200 MHz and check if the displayed amplitude is more than 4.25 divisions (–3 dB referred to 6 divisions).
5. Set the AC-DC switch to DC-1V and similarly check the

frequency response at 1V/div deflection factor. The displayed amplitude of –3.5 dB referred to 6 divisions is 4.00 divisions.

4. Attenuator Phase

Rating

±2%

Check and Calibration

1. Set the controls as follows:

TRI	In
AC-DC (CH3)	DC -0.1V
TRIGGER	CH3
A TIME/DIV	0.5 mSEC

2. Connect the accessory 10:1 probe between the CH3 input connector and the OUTPUT 2 connector of the scope calibrator, SC-340.
3. Set the controls of the SC-340 as follows:

SQUARE WAVE 1	Push
AMPLITUDE	5V

4. As the above-mentioned operation allows 5 divisions amplitude of the signal on the CRT, adjust the phasing capacitor of the probe so that the correct phasing can be obtained and check if the adequate Attenuator Phasing is given. (see Fig. 6-9) If incorrect phasing is given in the Attenuator Phasing, adjust C330 (see Fig. 6-1).
5. Set the AC-DC and AMPLITUDE switches to DC-1V and 5V respectively, and check if the correct phasing is given in the Attenuator Phasing and Probe Phasing. If the incorrect phasing is given, adjust C323 (for Attenuator Phasing)/C324 (for Probe Phasing) (see Fig. 6-1).

Cascade Connection

1. Output Potential of Channel 1 Signal

Check and Calibration

1. Set the controls as follows:

MODE (vertical)	CH1
VOLTS/DIV (CH1, CH2)	5 mV
AC-GND-DC (CH1, CH2)	GND
CH1 POSITION	Adjust to shift the trace to the center of the CRT.

2. Set the vertical MODE switch to CH2 and set the trace to the center of the CRT by the CH2 POSITION control.
3. Connect the CH1 OUT connector on the rear panel to the CH2 input connector using a BNC cable.
4. Check if the trace shifts from the center of the CRT by setting the CH2 AC-GND-DC switch to DC.
5. If it shifts, R453 CH1 OUT DC LEVEL (see Fig. 6-5).

2. Deflection Factor

Rating

1 mV/div ±3%

Check and Calibration

1. After the above-mentioned operation, set the CH1 and CH2 AC-GND-DC switches to DC and AC respectively.
2. Connect the OUTPUT 2 connector of the scope calibrator, SC-340 to the CH1 input connector and set the controls of the SC-340 as follows:

SQUARE WAVE 1	Push
AMPLITUDE	5mV

3. Set the display to the center of the CRT with the CH2 POSITION control and check if the displayed amplitude is within 5 divisions ±3%.
4. If the error is out of the rating, adjust R443 CH1 OUT GAIN (see Fig. 6-5).

3. Frequency Response

Rating

DC to 20 MHz –3 dB

Check

1. After the above-mentioned operation, set the CH2 AC-GND-DC switch to DC.
2. Connect the signal of a standard signal generator (I) to the CH1 input connector.
3. Set the signal frequency to 50 kHz and adjust the signal output voltage to set the displayed amplitude to 6 divisions.
4. Set the signal frequency to 20 MHz and check if the displayed amplitude is more than 4.25 divisions (–3 dB

referred to 6 divisions).

4. Noise

Rating

0.5 division peak to peak or less

Check

1. After the above-mentioned operation, set the CH1 AC-GND-DC switch to GND.
2. Allows the free-running sweep.
3. Check if the noise of the trace is 0.5 division peak to peak or less.

— Triggering —

A Trigger Bias

Calibration

1. Set the vertical MODE switch to CH1 and the HORIZ DISPLAY switch to A.
2. Connect the OUTPUT 2 connector of the scope calibrator, SC-340 to the CH1 input connector and push the SINE WAVE ≒ 1 kHz button.
3. Rotate the VOLTS/DIV switch and the VARIABLE control of CH1 to set the displayed amplitude to 6 divisions start allow triggering.
4. Rotate R721 (see Fig. 6-1) gradually throughout the entire range so as to confirm the two ranges "triggering" and "no triggering". Set R721 to the mid-range between the two ranges.

Level Centering of A Triggering

Check and Calibration

1. Set the controls as follows:

MODE (vertical)	CH1
TRIGGER	CH1
HORIZ DISPLAY	A
MODE (sweep)	AUTO or NORM
AC-HF REJ-DC	AC

2. Connect the OUTPUT 2 connector of the scope calibrator, SC-340 to the CH1 input connector and push the SINE WAVE ≒ 1 kHz button.
3. Rotate the VOLTS/DIV switch and the VARIABLE control of CH1 to set the displayed amplitude to 4 divisions.
4. Set the display to the center 4 divisions of the CRT.
5. Allow the triggering by setting the LEVEL/SLOPE control of the A Triggering to the mid-position.
6. Repeat the push-pull switching of the LEVEL/SLOPE control and check if both sweeps of positive-going slope and negative-going slope start from the same point on the CRT.
   If there is space between the starting points, adjust R641 SLOPE BAL (see Fig. 6-3).
7. Check if the starting point is positioned on the horizontal center line of the graticule.
   If the start point is not on the center line, adjust R666A LEVEL (see Fig. 6-3).
8. Without rotating the LEVEL/SLOPE control, set the AC-HF REJ-DC switch to DC and perform the check in the same way with item 7. If the start point is not positioned on the center line, adjust R187A CH1 TRIG BAL (see Fig. 6-5).
9. Set the vertical MODE and TRIGGER switches to CH2 respectively, connect the OUTPUT 2 connector to the CH2 input connector and perform the check and calibration in the same way with item 8.
   Variable resistor: R187B CH2 TRIG BAL (see Fig.6-5).
10. Set the TRIGGER switch to NORM and perform the check and calibration in the same way with item 8.
    Variable resistor: R305 COMP TRIG BAL (see Fig.6-5).
11. Set the controls as follows:

TRI	In
TRIGGER	CH3
AC-DC	AC-0.1V
CH3 POSITION	Adjust to set the trace to the center of the CRT.

12. Connect the OUTPUT 2 connector to the CH3 input connector, adjust the signal output voltage to set the displayed amplitude to 4 divisions and perform the check and calibration in the same way with item 8.
    Variable resistor: R343 CH3 DC BAL (see Fig. 6-5).

Level Centering of B Triggering

Check and Calibration

1. Set the controls as follows:

MODE (vertical)	CH1
HORIZ DISPLAY	B (DLY'D)
MODE (sweep)	AUTO
A TIME/DIV	1 mSEC
AUTO-TRIG	TRIG
AC-DC (B Triggering)	AC
B TIME/DIV	0.5 mSEC

2. Connect the OUTPUT 2 connector of the scope calibrator, SC-340 to CH1 input connector and push the SINE WAVE ≒ 1 kHz button.
3. Rotate the VOLTS/DIV switch and the VARIABLE control of CH1 to set the displayed amplitude to 4 divisions.
4. Set the display to the center 4 divisions of the CRT.
5. Allow the triggering by setting the LEVEL/SLOPE control of the B Triggering to the mid-position.
6. Repeat the push-pull switching of the LEVEL/SLOPE control and check if both sweeps of positive-going slope and negative-going slope start from the same point on the CRT.
   If there is space between the starting points, adjust R1024 SLOPE BAL (see Fig. 6-1).
7. Check if the starting point is positioned on the horizontal center line of the graticule.
   If a distance of the starting point from the center line is made, adjust R916 LEVEL CENT (see Fig. 6-3).
8. Without rotating the LEVEL/SLOPE control, set the AC-DC switch of the B Triggering to DC and perform the check and calibration in the same way with item 7.
   Variable resistor: R925 B INT DC LEVEL (see Fig.6-3).
9. Set the INT-EXT switch to EXT.
10. Connect the OUTPUT 2 connector to the CH1 input connector and the TRIG INPUT connector by using a BNC-T connector, and perform the check and calibration in the same way with item 7.
    Variable resistor: R914 EXT DC LEVEL (see Fig.6-3).

– Sweep –

Jitterless Circuit

Calibration

1. Switch off the power and short between TP860 (see Fig. 6-1) and the chassis by using a suitable wire.
2. Switch on the power.
3. Set the controls as follows:

HORIZ DISPLAY	A
MODE (sweep)	AUTO
AC-HF REJ-DC	AC

4. Connect the signal of a sine wave generator to the CH1 input connector.
5. Set the signal frequency to 10 kHz and set the A TIME/DIV switch to 20 μSEC.
6. Rotate the VOLTS/DIV switch and the VARIABLE control of CH1 to set the displayed amplitude to 4 divisions and allow the stable triggering by adjusting the LEVEL/SLOPE control of the A Triggering.
7. Rotate R733 2ND GATE STAB (see Fig. 6-1) fully clockwise.
8. Observing the waveform at TP740 (see Fig. 6-1) with a test oscilloscope, rotate R741 1ST GATE STAB (see Fig. 6-1) gradually throughout the entire range so as to make sure of three ranges, (a), (b) and (c) shown in Fig. 6-10. Set R733 to the mid-range of the (b) range.
9. Observing the waveform at TP730 (see Fig. 6-1) with a test oscilloscope, rotate R733 2ND GATE STAB (see Fig. 6-1) gradually throughout the entire range so as to make sure of the three ranges, (a), (b) and (c) shown in Fig. 6-11. Set R733 to the mid-range of the (b) range.

Operation of B Sweep

Calibration

1. Set the controls as follows:

HORIZ DISPLAY	A
AUTO-TRIG	TRIG
A TIME/DIV	1 mSEC
B TIME/DIV	0.5 mSEC
DELAY TIME MULT	3.00

2. Connect the OUTPUT 2 connector of the scope calibrator, SC-340 to the CH1 input connector and push the SINE WAVE ≒ 1 kHz button.
3. Rotate the VOLTS/DIV switch and the VARIABLE control of CH1 to set the displayed amplitude to 4 divisions and allow the triggering by adjusting the LEVEL/SLOPE control of the A Triggering.
4. Set the HORIZ DISPLAY switch to B(DLY'D) and allow the triggering by adjusting the LEVEL/SLOPE control of the B Triggering.
5. Rotate R1034 B SWEEP STAB (see Fig. 6-1) gradually throughout the entire range so as to make sure of the three ranges, "no sweep", "triggered sweep" and "free-running sweep". Set R1034 to the mid-range of the "triggered sweep".

Start Point of A Sweep

Check and Calibration

1. Set the controls as follows to provide the B(DLY'D) sweep.

HORIZ DISPLAY	B(DLY'D)
MODE (sweep)	AUTO
AUTO-TRIG	AUTO

2. Set the HORIZ DISPLAY switch to A and check if the A Sweep starts from the same point with the B (DLY'D) sweep.
3. If a distance is made between start points, adjust R821 A SWEEP START (see Fig. 6-1).

Magnifier Centering

Check and Calibration

1. Connect the CAL 0.6V terminal to the CH1 input connector using the accessory probe.
2. Set the controls as follows:

VOLTS/DIV	10 mV
A TIME/DIV	1 mSEC

3. Set the starting point of the display (rising of the calibration voltage waveform) to the vertical center line of the graticule with the horizontal Position control.
4. Pull the FINE (PULL x10) control and check if the start point shifts from the vertical center line.
5. If the start point shifts excessively, with the Horizontal Position control, set the start point of the magnified sweep correctly to the vertical center line. Next, push the FINE (PULL x10) control and adjust R1454 MAG CENT (see Fig. 6-6) so that the start point of the unmagnified sweep is positioned to the vertical center line correctly.

Sweep Rate

Rating

Accuracy I (over center 8 divisions): ±2%

Accuracy II (over any 2 divisions within center 8 divisions): ±5%

Fig. 6-10 Waveform at TP740

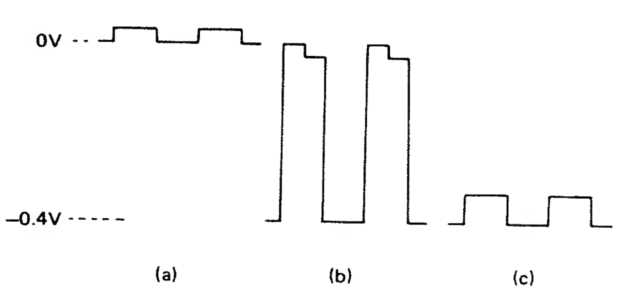
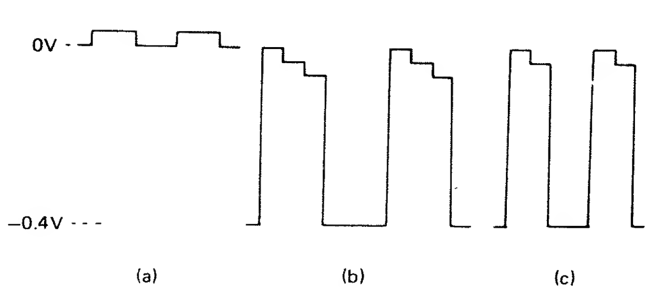


Fig. 6-11 Waveform at TP730



Check I (A Sweep)

1. Set the controls as follows:

HORIZ DISPLAY	A
MODE (sweep)	NORM
A TIME/DIV	1 mSEC
A VARIABLE	CALIB

2. Connect the OUTPUT 2 connector of the scope calibrator, SC-340 to the CH1 input connector.
3. Set the controls of the SC-340 as follows:

PULSE TRAIN	Push
REPETITION	1 mSEC

4. Allows the triggering and set the start pulse to a position 1 division right from the left end of the graticule.
5. Check the accuracy I and II. (see Fig. 6-12 and 6-13)
6. Repeat the same check of the accuracy from 0.5 SEC to 0.1μSEC.
7. Push the PULSE TRAIN HF button of the SC-340 and repeat the same check of the accuracy from 50 nSEC to 10 nSEC. At this time, set the 10 nS-20 nS switch of the SC-340 to 20 nS for 50 and 20 nSEC ranges and 10 nS for 10 nSEC range.

Check II (B Sweep)

1. After the above-mentioned check, set the controls as follows:

HORIZ DISPLAY	B(DLY'D)
AUTO-TRIG	TRIG
A TIME/DIV	2 mSEC
B TIME/DIV	1 mSEC

2. Repeat the check of the B sweep rate in the same way with the Check I.

Calibration I [When both A & B sweep rates have the same tendency]

1. Calibrate both errors with R1435 NORM GAIN (see Fig. 6-6).

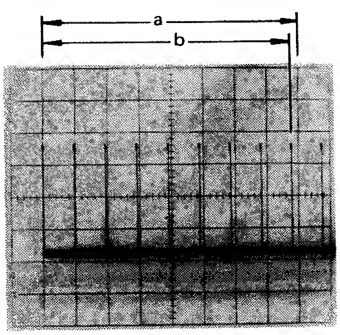
Calibration II [When all ranges have the same tendency for error]

1. In the A Sweep, calibrate the errors with R1153 A SWEEP CAL (see Fig. 6-6).
2. In the B Sweep, calibrate the errors with R1082 B SWEEP CAL (see Fig. 6-1).

Calibration III [When the error in a particular range is large]

1. For calibration of the error in each group shown in Tables 6-5 and 6-6, use the calibration control assigned to the group (see Table 6-5 and 6-6 and Figs. 6-1 and 6-6).

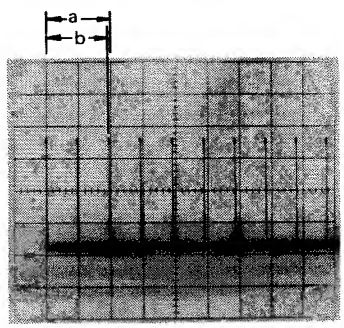
Fig. 6-12 Sweep rate error (I)



$$\text{Error rate} = \frac{a-b}{a} \times 100\ (\%)$$

where a : Horizontal effective scale (8 div)
b : Measured value of pulse train corresponding to a.

Fig. 6-13 Sweep rate error (II)



$$\text{Error rate} = \frac{a-b}{a} \times 100\ (\%)$$

where a : Any 2 divisions of effective scale
b : Measured value of pulse train corresponding to a.

2. In each group shown in Tables 6-7 and 6-8, calibrate by replacing the timing capacitor or connecting a capacitor with a value relative to the error, parallel to the timing capacitor. (See the schematic diagram.)
3. In a particular range, calibrate by checking the value of the timing resistors (see the schematic diagram) and replacing the resistor of which the error is large.

Note: There is no calibration control is for accuracy II. If the accuracy is poor, troubleshooting must be conducted to find and replace defective parts.

Table 6-7 Timing capacitor of A Sweep

A TIME/DIV	Timing capacitor
10 μSEC ~ 50 μSEC	C 1183
0.1mSEC ~ 0.5mSEC	C 1182
1 mSEC ~ 5 mSEC	C 1181
10 mSEC ~ 0.5 SEC	C 1187

Table 6-8 Timing capacitor of B Sweep

B TIME/DIV	Timing capacitor
10 μSEC ~ 50 μSEC	C 1194
0.1mSEC ~ 0.5mSEC	C 1193
1 mSEC ~ 5 mSEC	C 1192
10 mSEC ~ 50 mSEC	C 1191

Table 6-5 Calibration control of A Sweep

A TIME/DIV	Calibration control
10 nSEC	R 1139
20 nSEC	R 1137
50 nSEC	R 1135
0.1μSEC ~ 0.5μSEC	C 1185
1 μSEC ~ 5 μSEC	C 1184

Table 6-6 Calibration control of B Sweep

B TIME/DIV	Calibration control
10 nSEC	R 1178
20 nSEC	R 1176
50 nSEC	R 1174
0.1μSEC ~ 0.5μSEC	C 1196
1 μSEC ~ 5 μSEC	C 1195

Sweep Rate at Magnified Sweep

Rating

Accuracy I (over center 8 divisions):

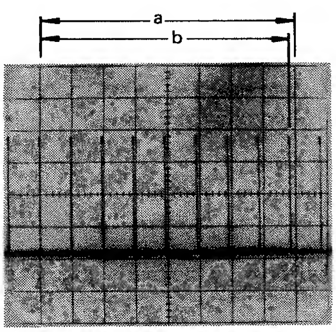
50 ms/div to 0.1 μs/div : ±3%

50 ns/div to 10 ns/div : ±4%

5 ns/div to 1 ns/div: : ±5%

Accuracy II (over any 2 divisions within center 8 divisions):

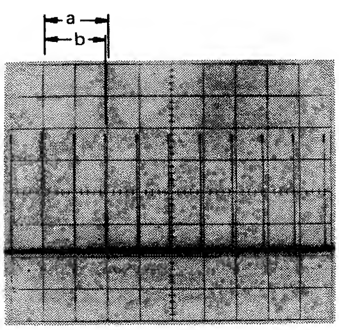
Fig. 6-14 Sweep rate error at magnified sweep (I)



$$\text{Error rate} = \frac{a-b}{a} \times 100\ (\%)$$

where a : Horizontal effective scale (8 div)
b : Measured value of pulse train corresponding to a.

Fig. 6-15 Sweep rate error at magnified sweep (II)



$$\text{Error rate} = \frac{a-b}{a} \times 100\ (\%)$$

where a : Any 2 divisions of effective scale
b : Measured value of pulse train corresponding to a.

50 ms/div to 0.1 μs/div	:	±5%
50 ns/div to 10 ns/div	:	±6%
5 ns/div to 1 ns/div	:	±10%

Note: The above-mentioned accuracy is rated excepting the following sweep from the starting point of the sweep: 25 divisions for 1 ns/div, 15 divisions for 2 ns/div, 6 divisions for 5 ns/div, 3 divisions for 10 ns/div, 1.5 division for 20 ns/div and 1 division for 50 ns/div to 50 ms/div.

Check and Calibration

1. After the above-mentioned "Check I", set the controls as follows and allow the triggering.

A TIME/DIV	0.1 mSEC
REPETITION	0.1 mSEC

2. Pull the FINE (PULL x10) control and set the A TIME/DIV switch to 1 mSEC.
3. Check the accuracy I (see Fig. 6-14).
4. If the accuracy is poor, calibrate the error with R1432 MAG GAIN (see Fig. 6-6).
5. Check the accuracy II (see Fig. 6-15).
6. Repeat the same check of the accuracy from 50 ms/div to 0.1 μs/div.
7. Push the PULSE TRAIN HF button of the SC-340 and perform the same check of the accuracy from 50 to 10 ns/div. At this time, set the 10 nS-20 nS switch of the SC-340 to 20 nS for 50 and 20 ns/div ranges and 10 nS for 10 ns/div range.
8. Connect the signal of a standard signal generator (II) to the CH1 input connector.
9. Perform the same check of the accuracy from 5 to 1 ns/div. At this time, set the signal frequency to 100 MHz for 5 ns/div range and 250 MHz for 2 and 1 ns/div ranges.
10. If the accuracy from 5 to 1 ns/div ranges is poor, calibrate the error with C1466 and C1483 (see Fig. 6-6).

Notes: Adjustment of C1466 and C1483 varies the accuracy of the unmagnified sweep rate from 50 to 10 ns/div, therefore these sweep rates must be checked and calibrated when C1466 and C1483 are rotated.

Delay Time

Check and Calibration

1. Set the controls as follows:

HORIZ DISPLAY	A INTEN
AUTO-TRIG	AUTO
A TIME/DIV	1 mSEC
B TIME/DIV	0.1 mSEC

2. Connect the OUTPUT 2 connector of the scope calibrator, SC-340 to the CH1 input connector.
3. Push the PULSE TRAIN ⎍ button and set the REPETITION switch to 1 mSEC.
4. Allow the triggering by adjusting the LEVEL/SLOPE control of the A Triggering and set the start pulse to the left end of the graticule.
5. Rotate the DELAY TIME MULT control fully counterclockwise and make sure that the dial indicates 0.50.
6. Set the start point of the B Sweep (intensified portion) to the second pulse from the start point of the A Sweep by rotating the DELAY TIME MULT control clockwise and check if the indication value of the dial is within 0.97 to 1.03.
7. Set the start point of the B Sweep to the tenth pulse by rotating the DELAY TIME MULT control further clockwise and check if the indication value of the dial is within 8.97 to 9.03.
8. If the errors are large, set the dial to 1.00 and adjust R955 DELAY START (see Fig. 6-1) to set the start point of the B Sweep to the second pulse, next, set the dial to 9.00 and adjust R953 DELAY STOP (see Fig. 6-1) to set the start point of the B Sweep to tenth pulse. Repeat the adjustments of R955 and R953.

Delay Jitter

Rating

1/20,000 or less

Check

1. Set the controls as follows:

HORIZ DISPLAY	A INTEN
AUTO-TRIG	AUTO
A TIME/DIV	1 mSEC

2. Connect the OUTPUT 2 connector of the scope calib-

rator, SC-340 to the CH1 input connector.

3. Set the controls of the SC-340 as follows and allow the triggering by adjusting the LEVEL/SLOPE control of the A Triggering.

   PULSE TRAIN ⎍ Push
   REPETITION 1 mSEC

4. Set the B TIME/DIV switch to 0.5 μSEC and the HORIZ DISPLAY switch to B (DLY'D).
5. Display one of the pulse trains on the center of the CRT by rotating the DELAY TIME MULT control slightly counterclockwise from the fully clockwise position and check that the jitter is within 1 division.

– X-Y Operation –

Spot Position

Check and Calibration

1. Set the start point of the trace to the left end of the graticule area.
2. Set the vertical MODE switch to X-Y and check if the spot is positioned within the graticule area.
3. If the spot is out of the graticule area, adjust R475 X-Y POS ADJ (see Fig. 6-5).

Deflection Factor

Rating

±3%

Check and Calibration

1. Set the controls as follows:

MODE (vertical)	X-Y
VOLTS/DIV (CH1,CH2)	10 mV
VARIABLE (CH1,CH2)	CALIB
AC-GND-DC(CH1,CH2)	DC

2. Connect the CAL 0.6V terminal to the CH2 input connector using the accessory probe.
3. Set the trace to the vertical center of the graticule area and check that the trace amplitude is within 6 divisions ±3%.
4. Connect the CAL 0.6V terminal to the CH1 input connector with the probe.
5. Set the trace to the horizontal center of the graticule area and check if the trace amplitude is within 6 divisions ±3%.
6. If the error in item 5 is large, adjust R462 X-Y GAIN (see Fig. 6-5).

X-Y Phase Difference

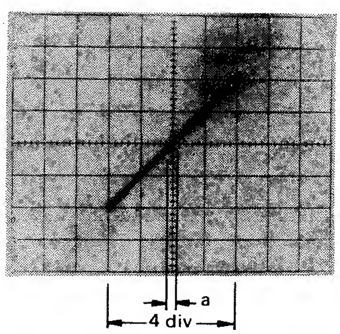
Rating

3° (for DC to 100 kHz)

Check

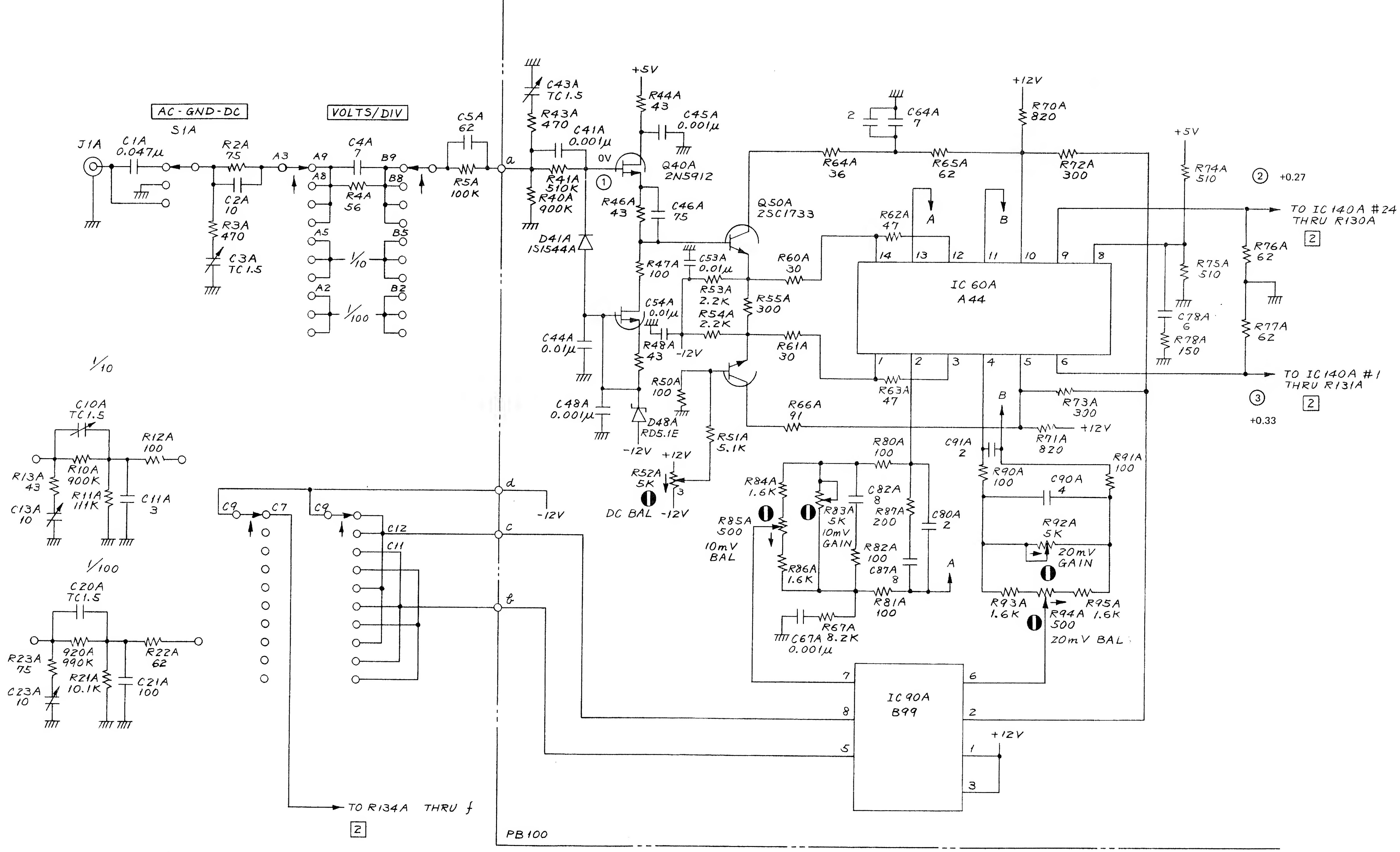
1. Set the controls as shown in item 1 of the above-mentioned "Deflection Factor".
2. Connect the signal of a standard signal generator (I) to the input connectors of CH1 and CH2 using a BNC-T connector.
3. Set the signal frequency to 100 kHz and adjust the signal output level to set the horizontal amplitude of the Lissajou's pattern to 4 divisions.
4. Check the width "a" in Fig. 6-16 which must be smaller than 0.2 division.

Fig. 6-16 X–Y phase difference



a: Opening on the horizontal center line

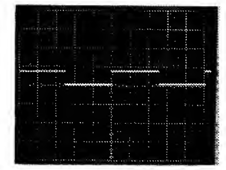
WAVEFORMS



SS-5321 / SS-5221
CH1 PRE AMPLIFIER (1) 1

K-606378 | 3

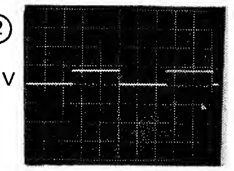
(1) 35mV



≈ −6.8V

0.2mS
AC COUPLED

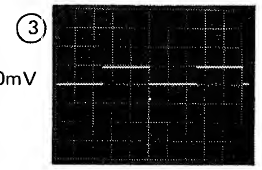
(2) 35mV



≈ −6.9V

0.2mS
AC COUPLED

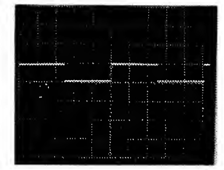
(3) 90mV



≈ −1.4V

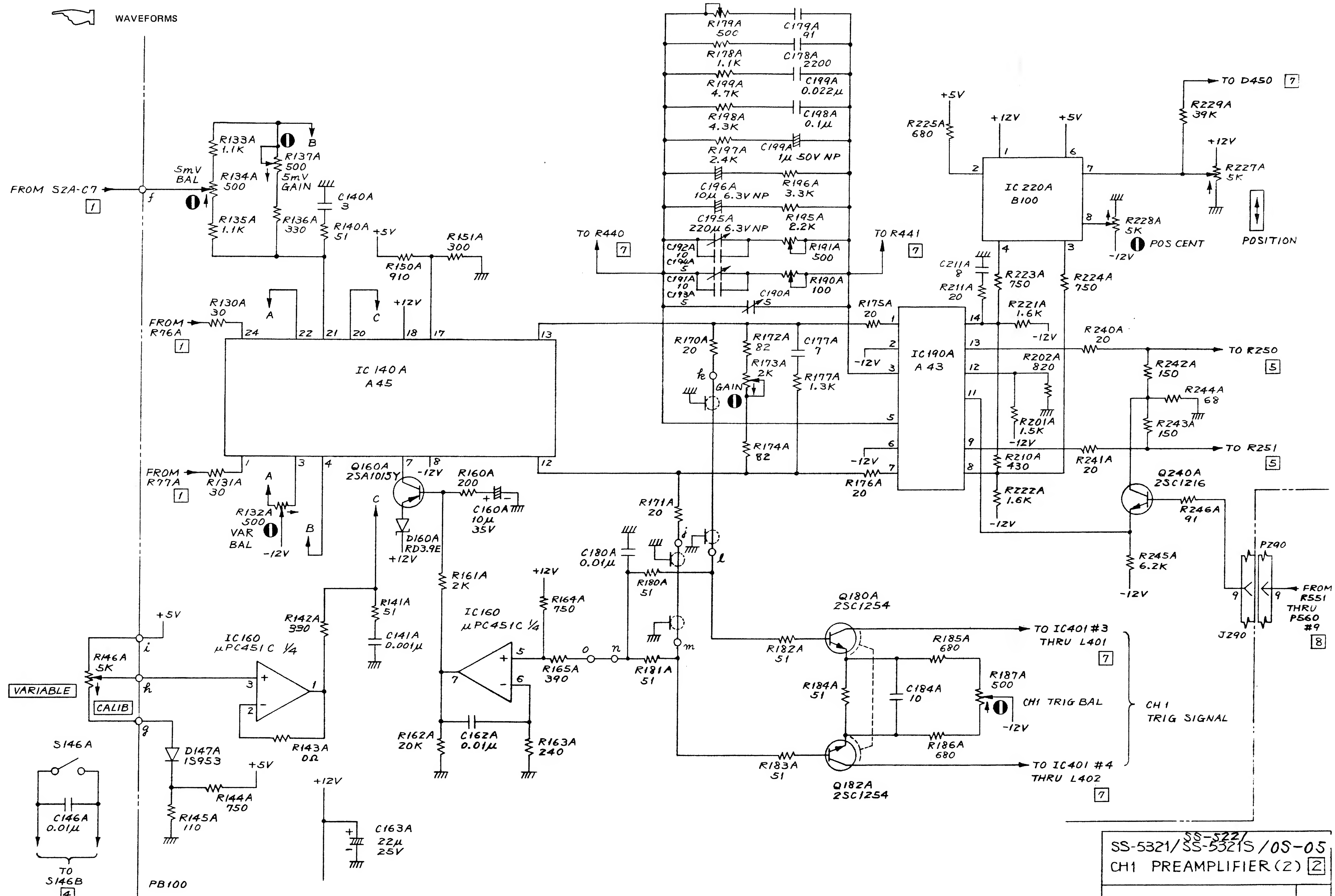
0.2mS
AC COUPLED

(4) 90mV



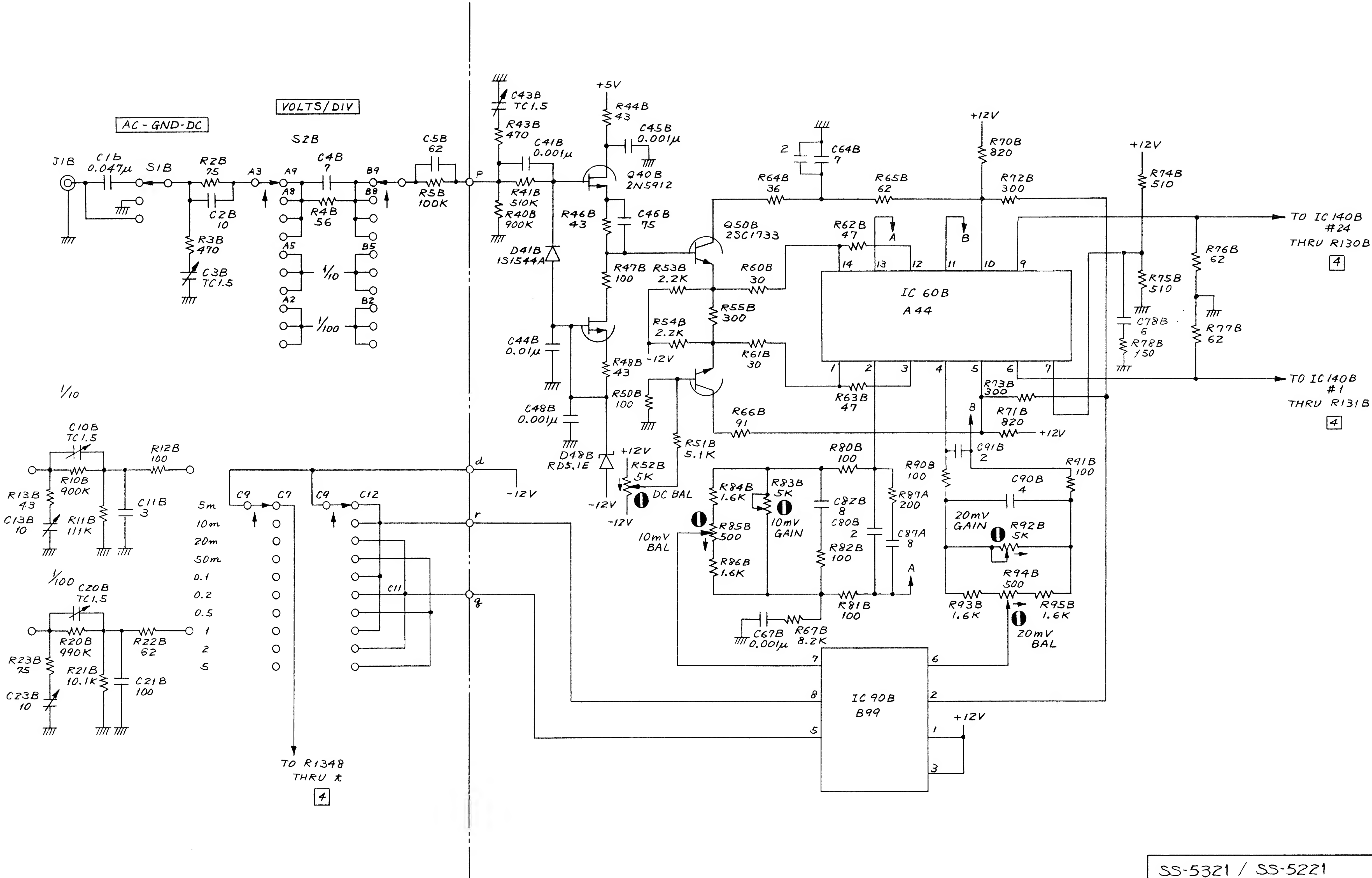
≈ −1.4V

0.2mS
AC COUPLED



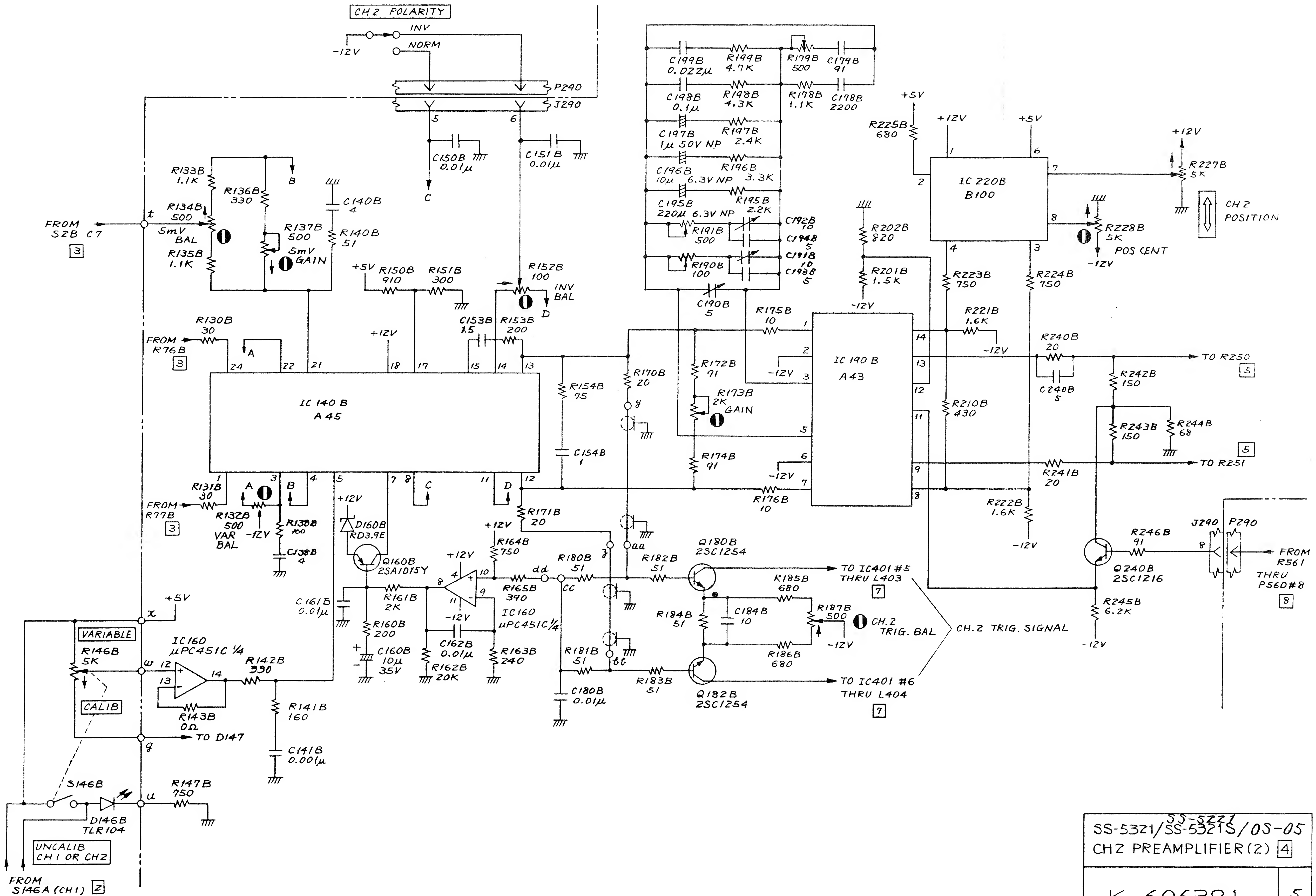
SS-5321/SS-5321S/OS-05
SS-5221
CH1 PREAMPLIFIER(2) 2

K-606379 3



SS-5321 / SS-5221
CH2 PREAMPLIFIER(1) [3]

K-606380 | 3

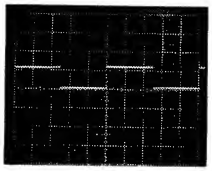


SS-5321/~~SS-5321S~~ SS-5221/OS-05
CH2 PREAMPLIFIER(2) 4

K-606381 | 5

1

0.1V

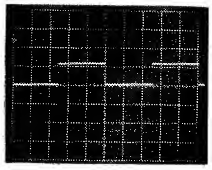


≈−70mV

0.2mS

2

0.1V

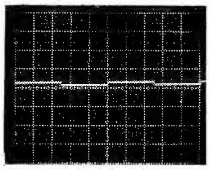


≈−60mV

0.2mS

3

10mV

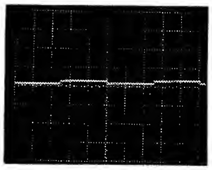


≈−1.4V

0.2mS
AC COUPLED

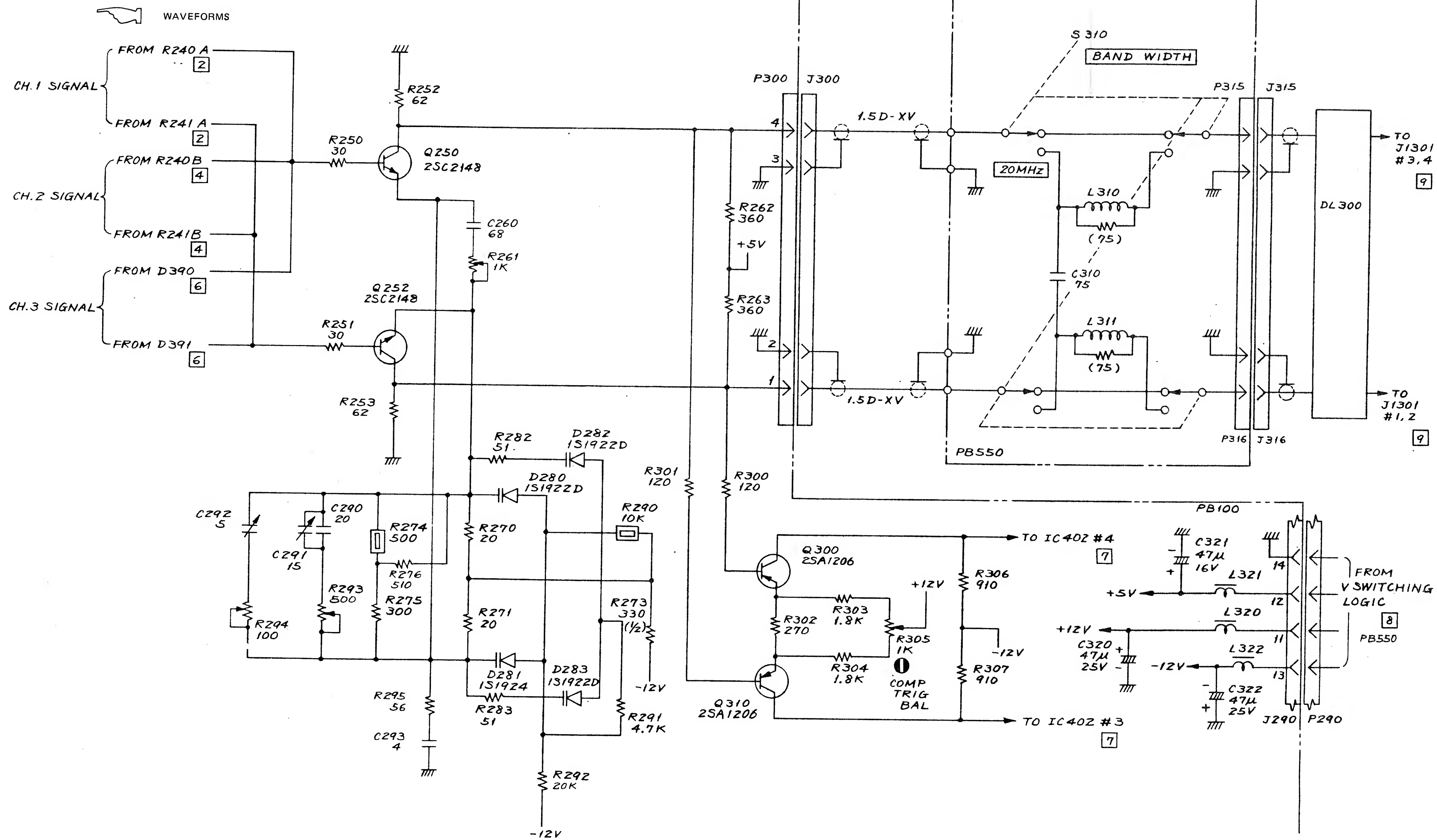
4

10mV



≈−1.4V

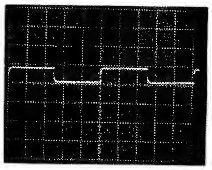
0.2mS
AC COUPLED



SS-5321/~~SS-5321S~~ SS-5221/OS-05
DELAY CABLE DRIVER 5

K-606382 | 2

1

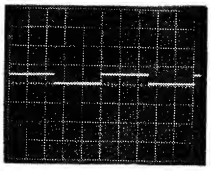


0.15V

0V

0.2mS

2

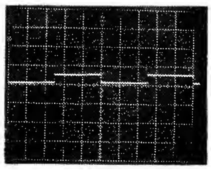


0.1V

≈−1.8V

0.2mS

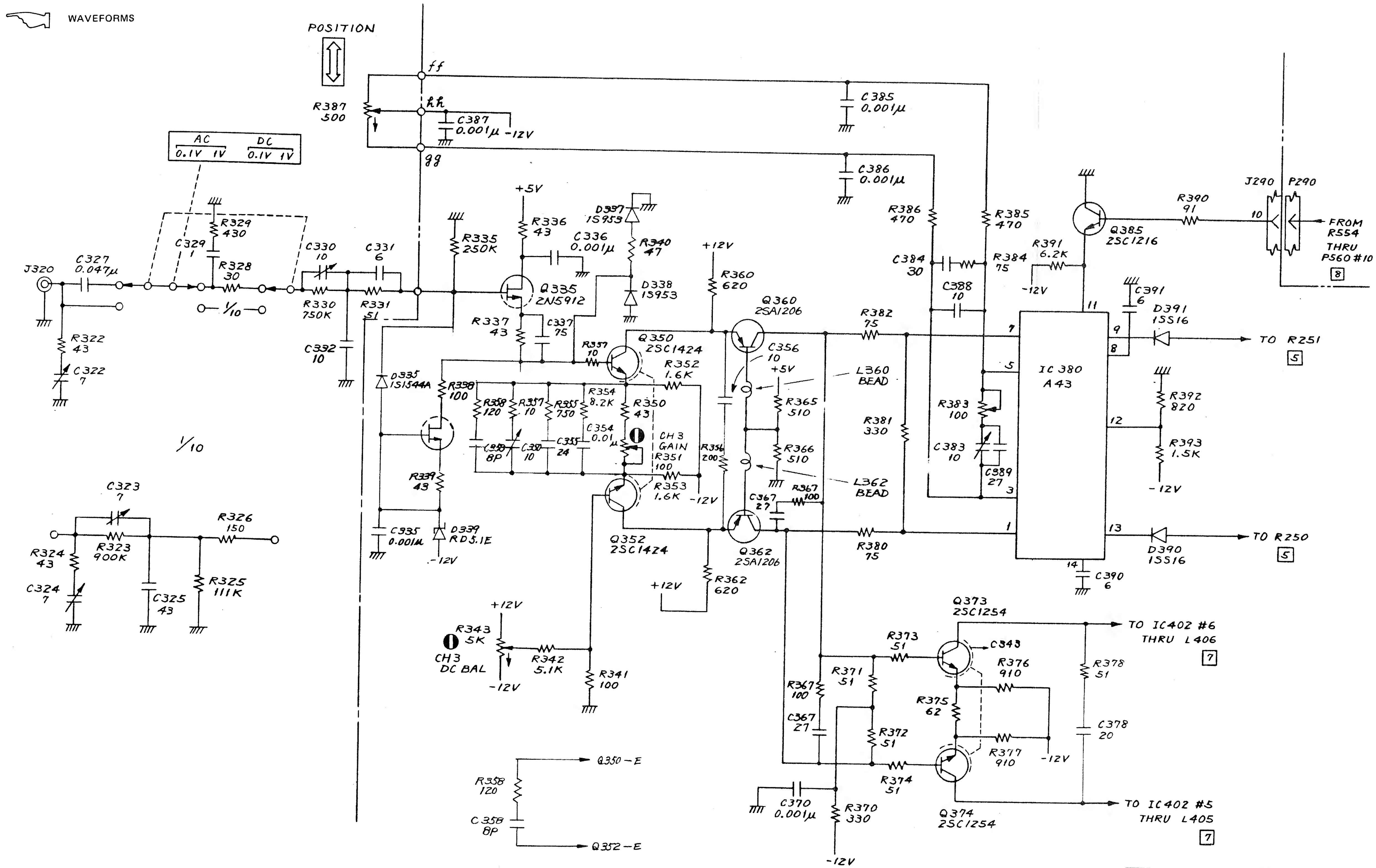
3



90mV

≈−1.7V

0.2mS

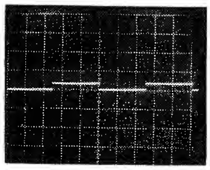


VOLTAGE & WAVEFORM READING CONDITIONS	
TRI	Push
TRIGGER	CH3

SS-5321/SS-5321S/OS-05 (SS-5221)
CH3 PREAMPLIFIER 6

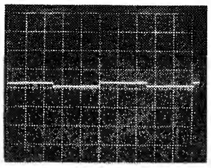
K-606383 6

①

15mV  ≈−2V

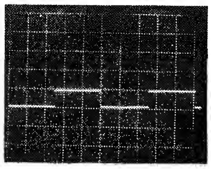
0.2mS
AC COUPLED

②

10mV  ≈−2V

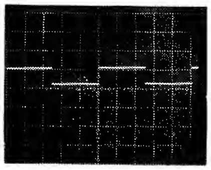
0.2mS
AC COUPLED

③

0.18V  0V

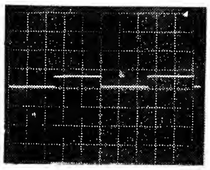
0.2mS

④

0.17V  0V

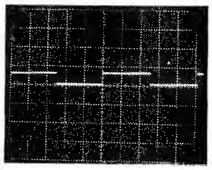
0.2mS

⑤

30mV  ≈−7.6V

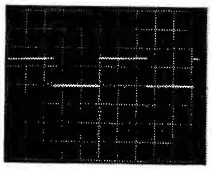
0.2mS
AC COUPLED

⑥

30mV  ≈−7.6V

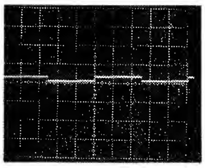
0.2mS
AC COUPLED

⑦

0.14V  0V

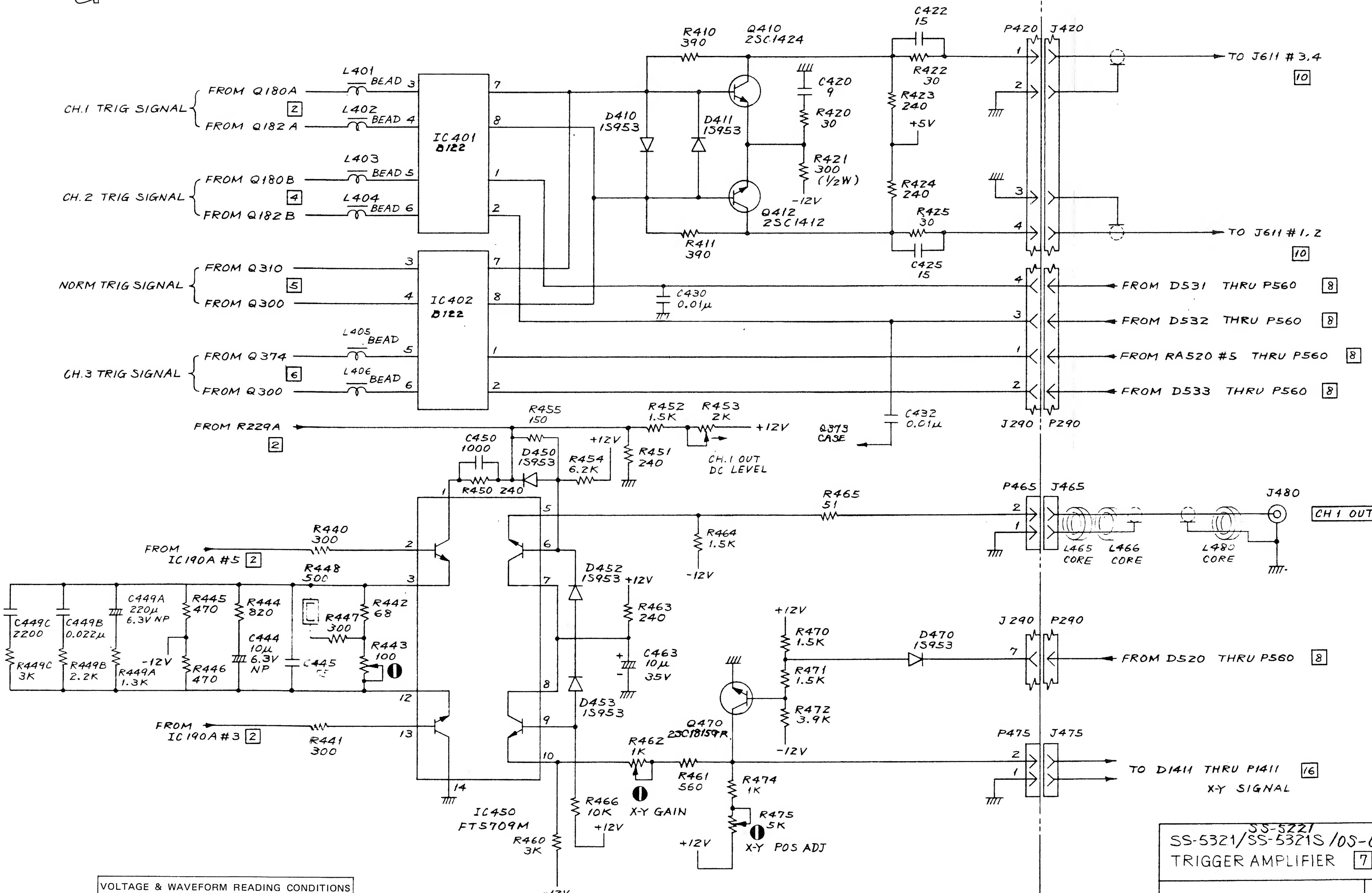
0.2mS

*⑧

10mV  ≈+1.5V

0.2mS

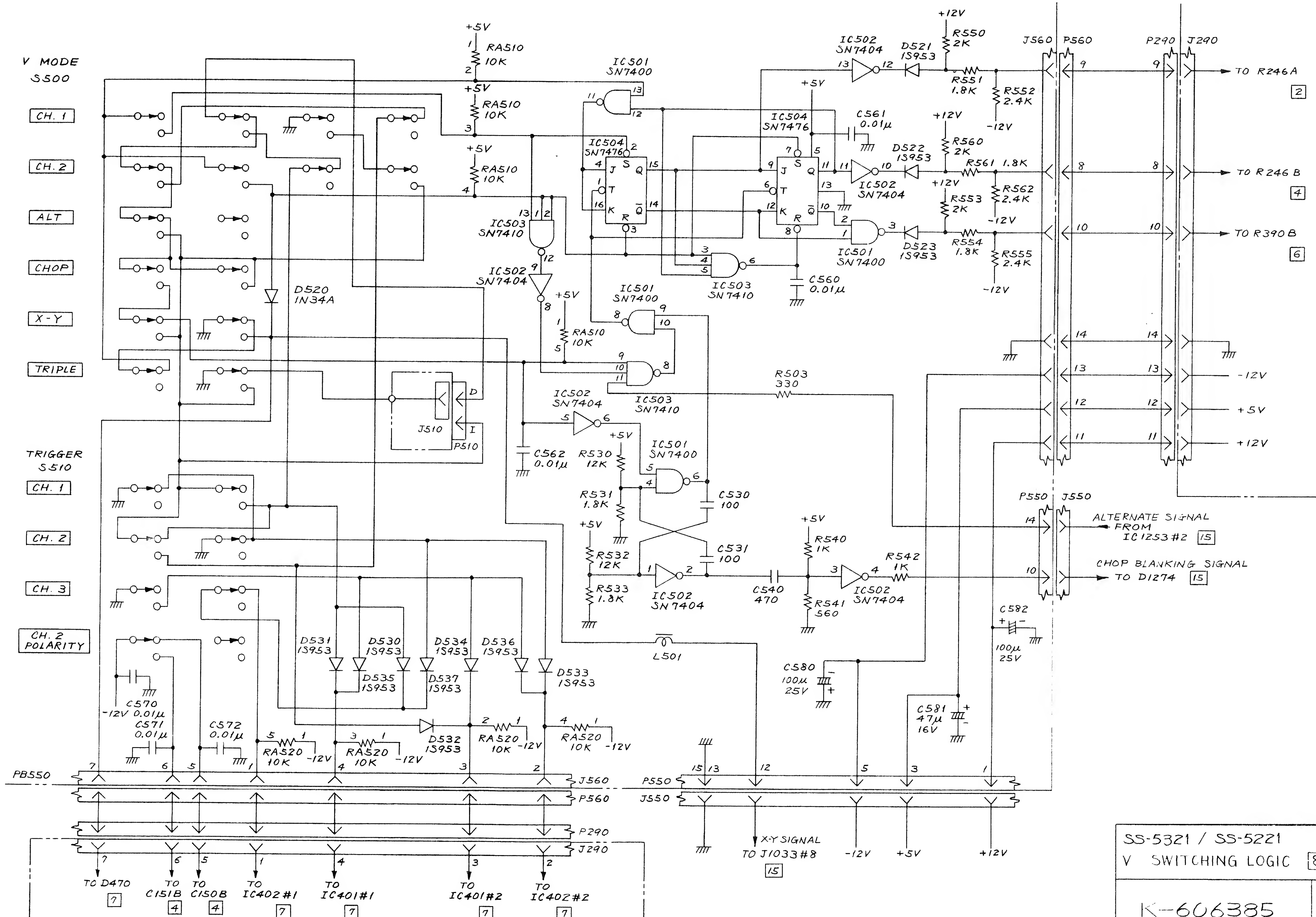
WAVEFORMS



VOLTAGE & WAVEFORM READING CONDITIONS
* MODE .... X–Y

SS-5221
SS-5321/SS-5321S/OS-05
TRIGGER AMPLIFIER 7

K–606384 | 4



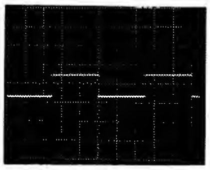
SS-5321 / SS-5221

V SWITCHING LOGIC 8

K-606385 1

①

0.12V

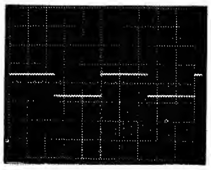


≈−40mV

0.2mS

②

0.12V

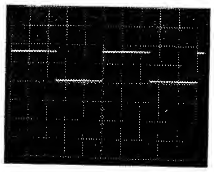


≈−40mV

0.2mS

③

7.5V

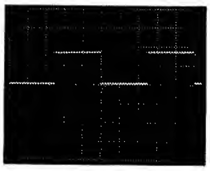


≈+25V

0.2mS

④

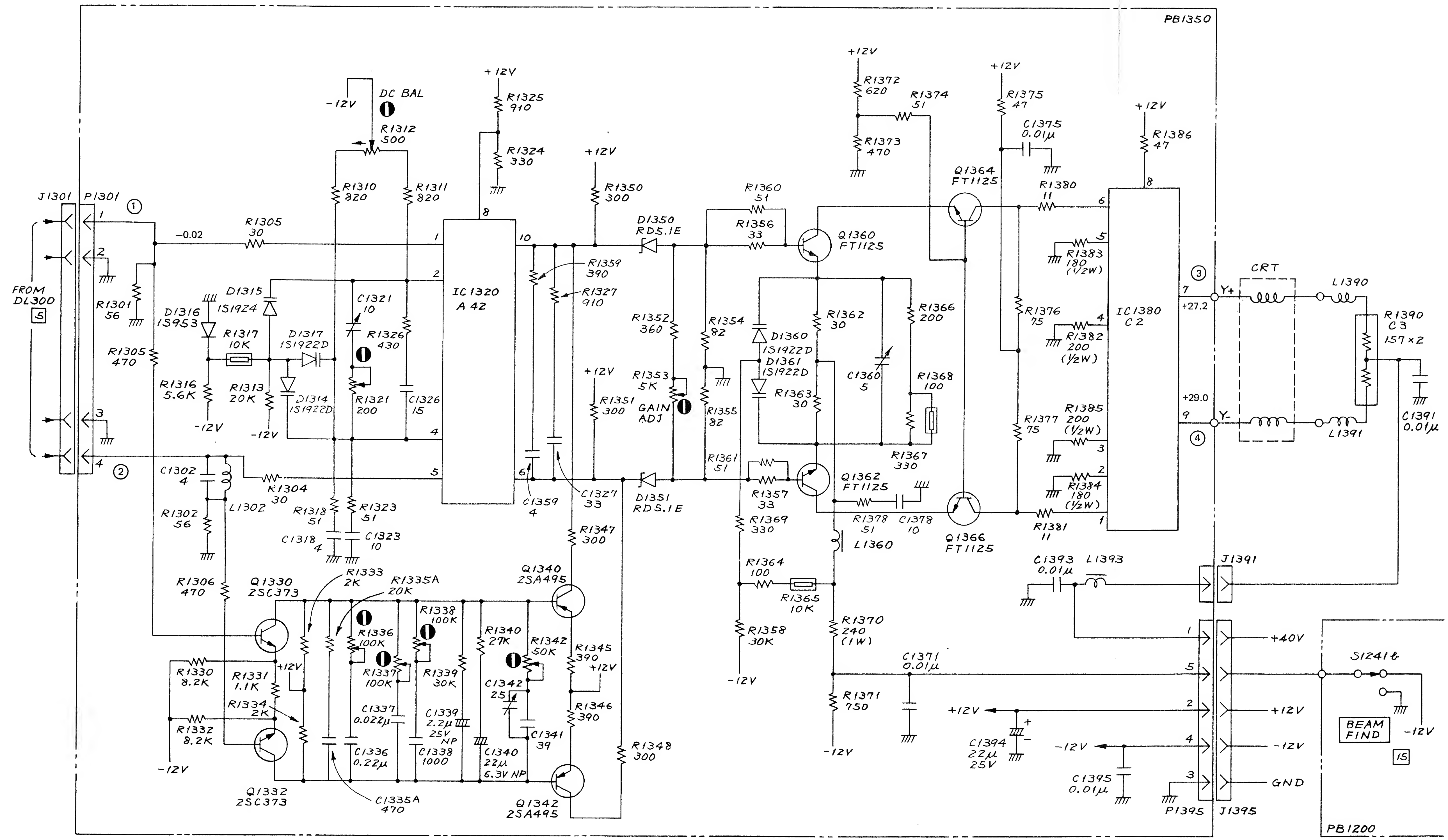
7.5V



≈+34V

0.2mS

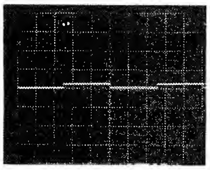
WAVEFORMS



SS-5321 / SS-5221
VERTICAL MAIN AMPLIFIER 9

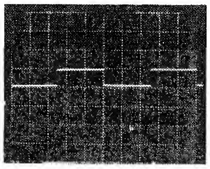
K-606386 | 3

(1)

10mV  ≈+1.6V

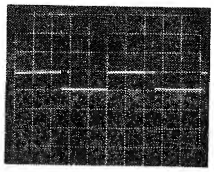
0.2mS
AC COUPLED

(2)

45mV  ≈+1.6V

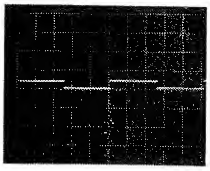
0.2mS
AC COUPLED

(3)

0.4V  ≈−50mV

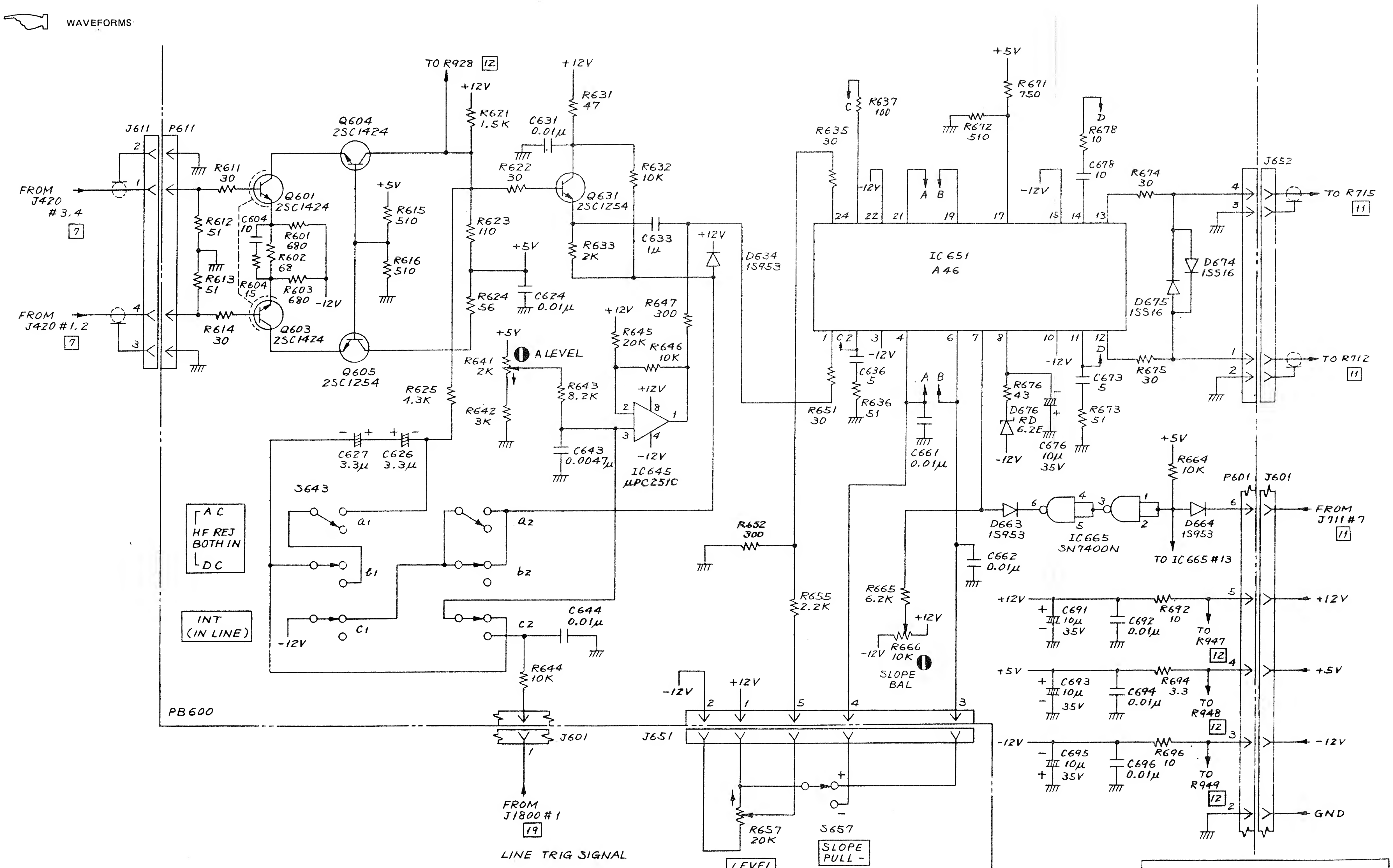
0.2mS

(4)

0.2V  ≈−2V

0.2mS

WAVEFORMS



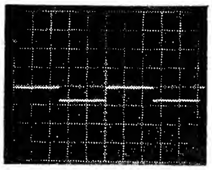
SS-5321/SS-5321S/SS-5221

A TRIGGER GENERATOR 10

K-606387 | 4

①

0.35V

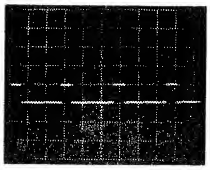


0V

0.2mS

②

0.5V



0V

5mS

③

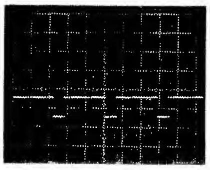
0.5V

0V

5mS

④

2V

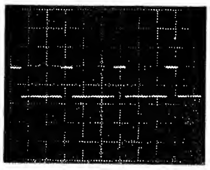


≈−3V

5mS

⑤

1.5V

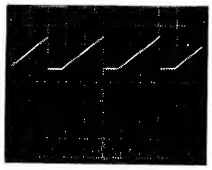


≈+1V

5mS

⑥

8.5V

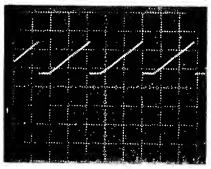


≈+3V

5mS

⑦

8.5V

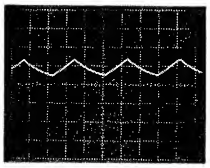


≈+3.5V

5mS

⑧

4V

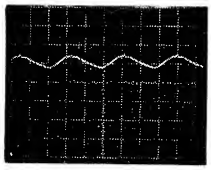


≈+3V

5mS

⑨

4V

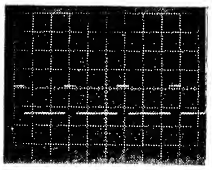


≈+6V

5mS

⑩

3V

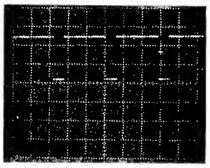


0V

5mS

⑪

11.5V

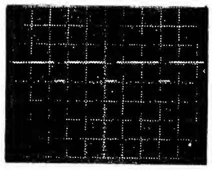


≈+0.8V

5mS

⑫

5V

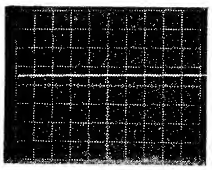


0V

5mS

⑬

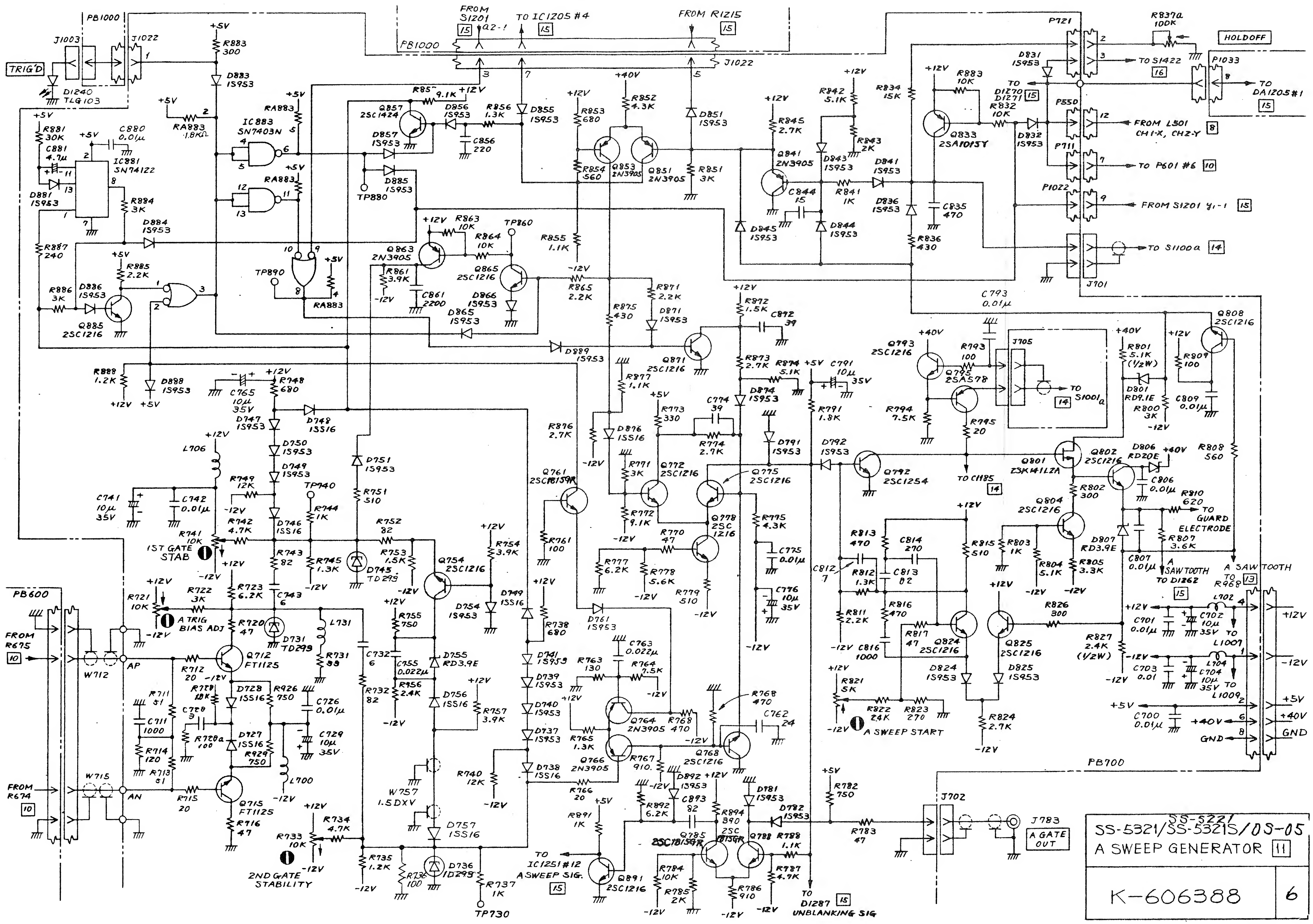
4.5V



≈+5V

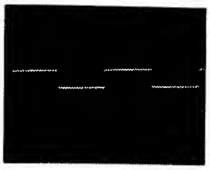
5μS

WAVEFORMS



SS-5321/SS-5321S/DS-05
SS-5221
A SWEEP GENERATOR 11
K-606388
6
HOLDOFF
TRIG'D
1ST GATE STAB
A TRIG BIAS ADJ
2ND GATE STABILITY
A SWEEP START
A GATE OUT
A SAW TOOTH
TO GUARD ELECTRODE
TO D1287 UNBLANKING SIG
TO IC1251 #12 A SWEEP SIG.
PB1000
PB600
PB700
TP730
TP740
TP860
TP880
TP890

①

0.5V  ≈+4V

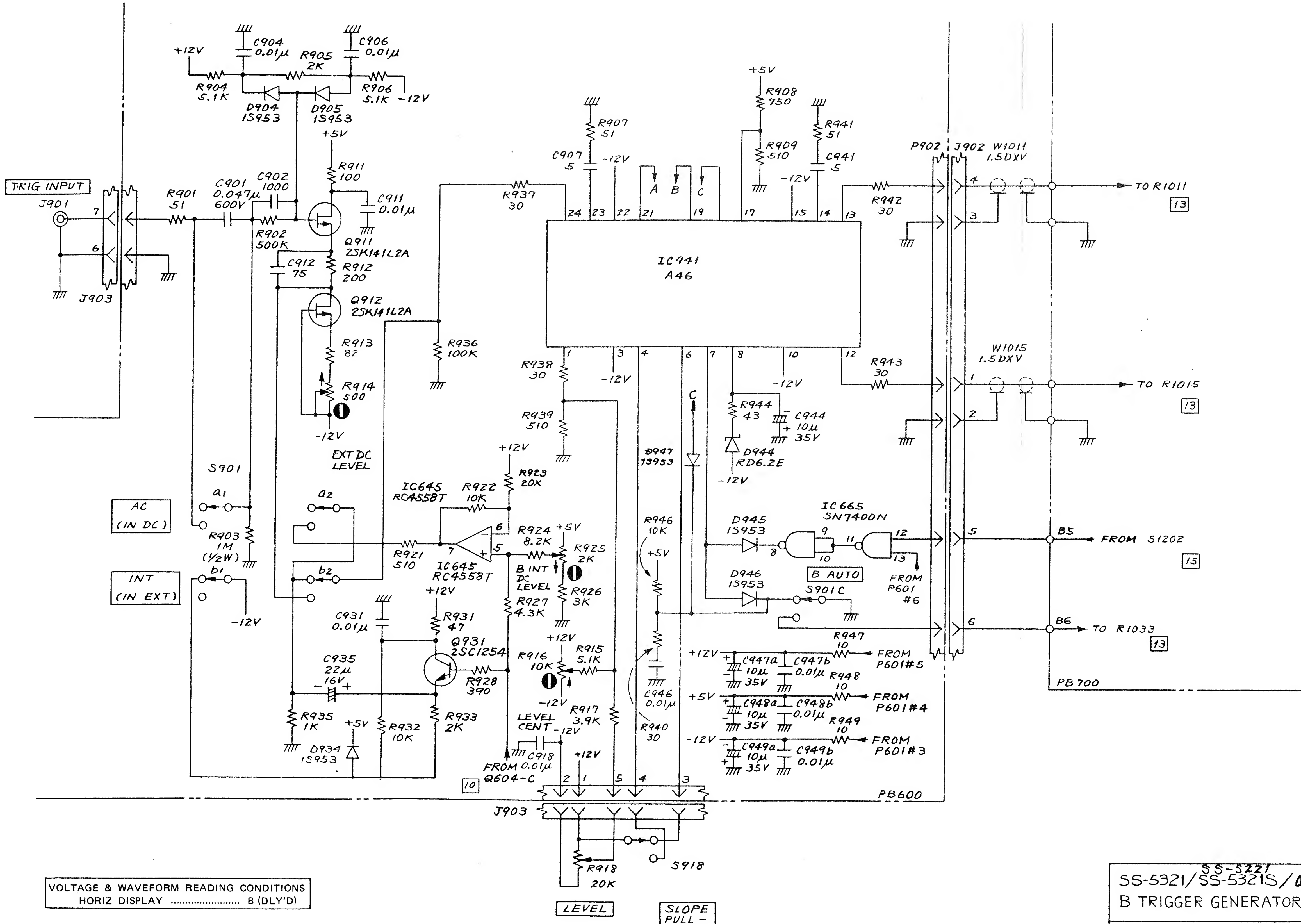
0.2mS

②

0.5V  ≈−0.1V

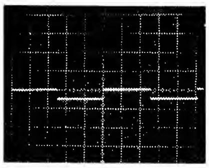
0.2mS

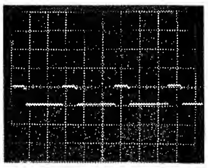
WAVEFORMS

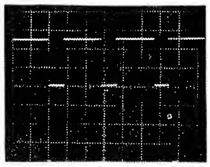


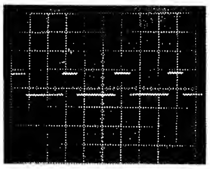
VOLTAGE & WAVEFORM READING CONDITIONS
HORIZ DISPLAY .... B (DLY'D)

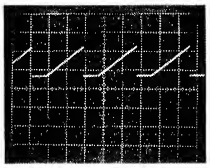
SS-5221 SS-5321/SS-5321S/OS-05 B TRIGGER GENERATOR 12	
K-606389	5

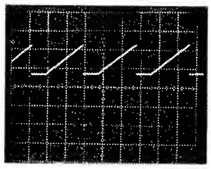
(1)
0.5V

≈−0.5V
0.2mS

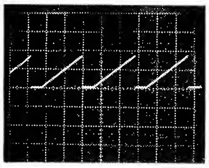
(2)
0.5V

0V
5mS

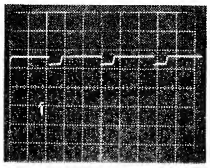
(3)
5V

0V
5mS

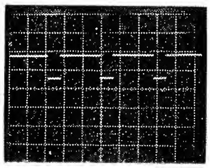
(4)
2.2V

≈+1.8V
5mS

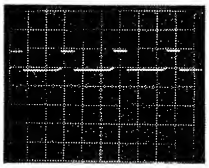
(5)
8V

≈+3V
5mS

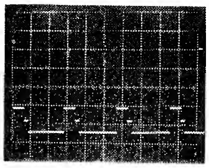
(6)
8V

≈+3V
5mS

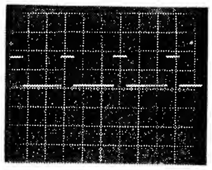
(7)
8V

0V
5mS

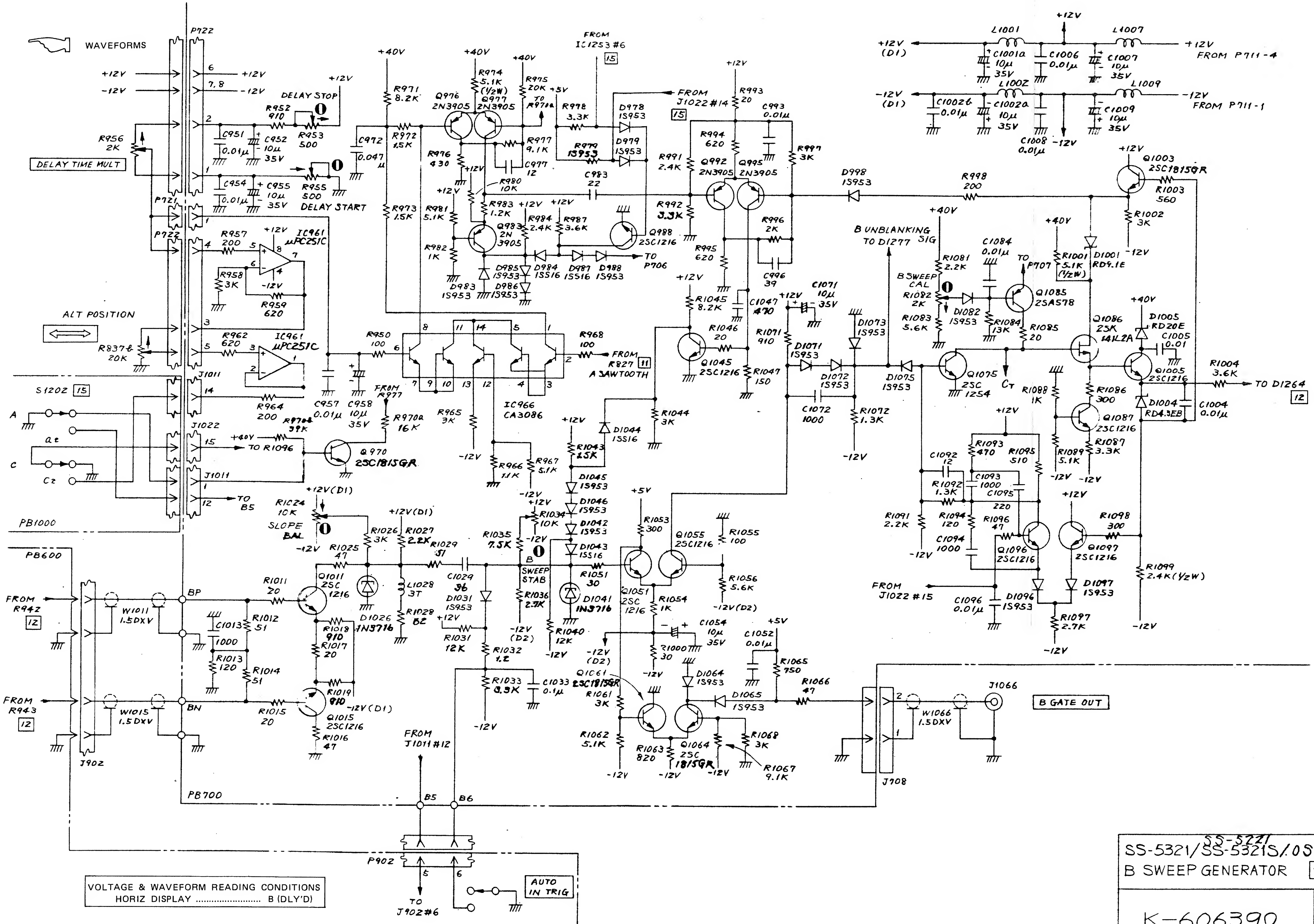
(8)
4V

≈+11V
5mS

(9)
6V

≈+3V
5mS

(10)
0.1V

≈+7V
5mS

(11)
70mV

≈−50mV
5mS

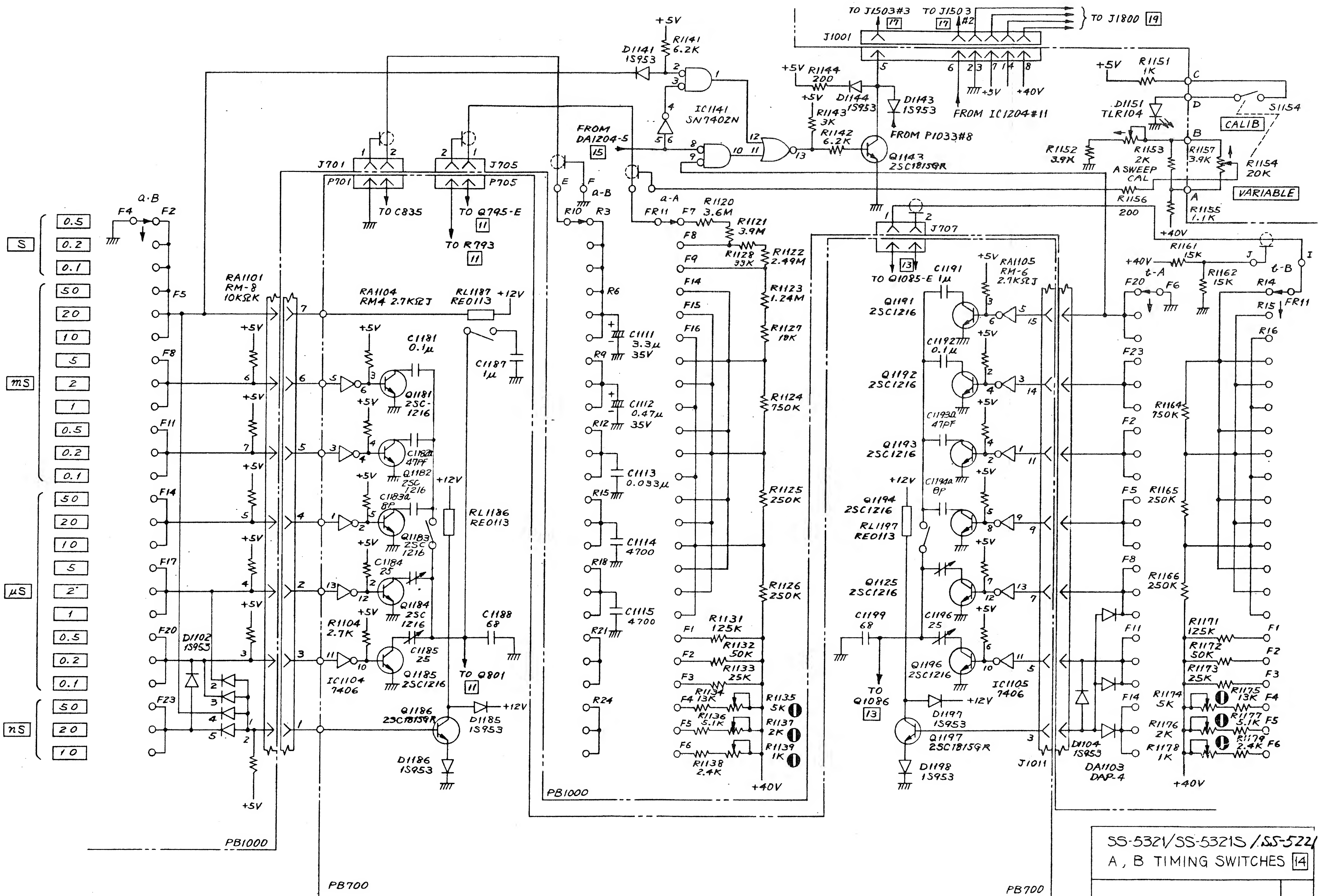
(12)
3V

≈+3V
5mS



VOLTAGE & WAVEFORM READING CONDITIONS
HORIZ DISPLAY .... B (DLY'D)

SS-5321/SS-5321S/OS-05
B SWEEP GENERATOR 13

K-606390 6



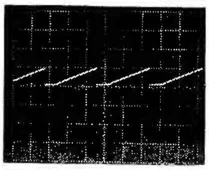
SS-5321/SS-5321S/SS-5221

A, B TIMING SWITCHES [14]

K-606391 | 5

1

0.18V

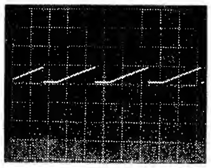


≈+1.5

5mS

* 2

0.18V

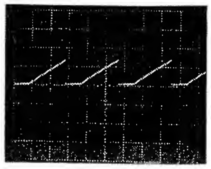


≈+1.5V

5mS

** 3

0.14V

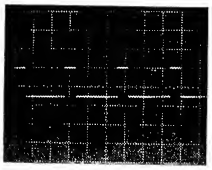


≈+1V

5mS

4

1.5V

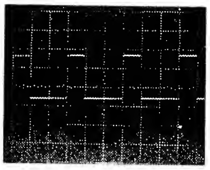


≈+1V

5mS

* 5

2.2V

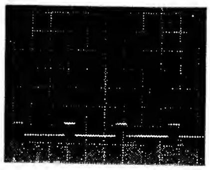


≈+1.8V

5mS

6

30mV

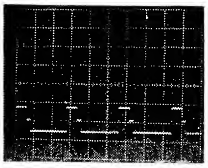


≈−0.1V

5mS

* 7

70mV

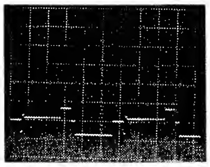


≈−60mV

5mS

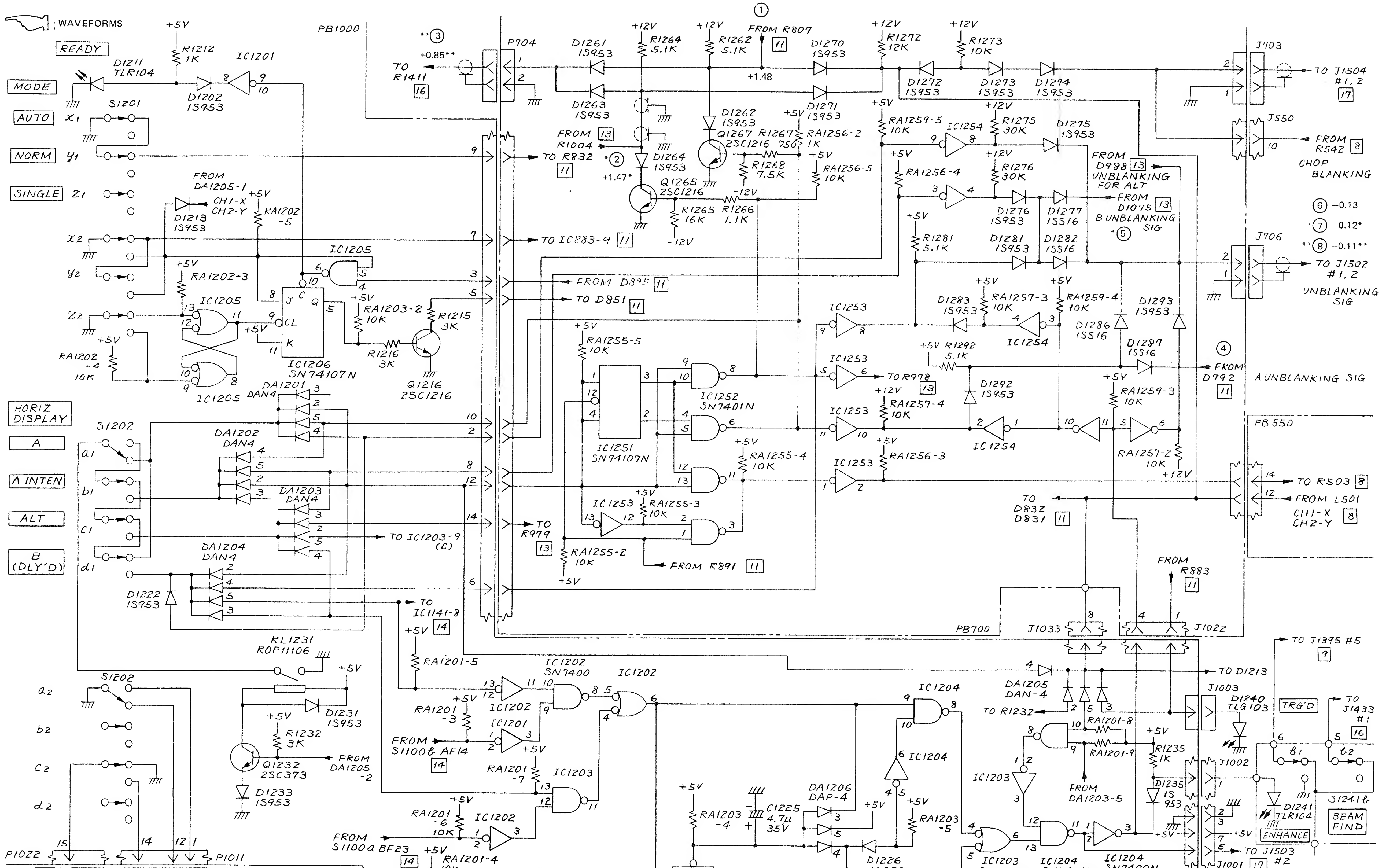
** 8

70mV



≈−90mV

5mS



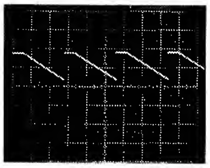
VOLTAGE & WAVEFORM READING CONDITIONS
* HORIZ DISPLAY .... B (DLY'D)
** HORIZ DISPLAY .... ALT

SS-5321 / SS-5221
HORIZONTAL CONTROL 15

K-606392 | 2

①

3V

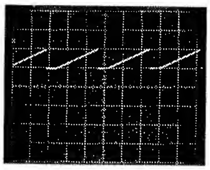


≈+7V

5mS

②

50V

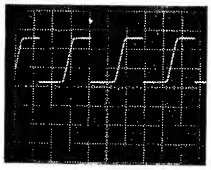


≈+50V

5mS

*③

120V

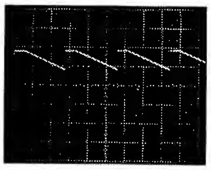


≈+10V

5mS

④

50V

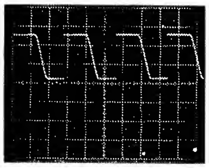


≈+90V

5mS

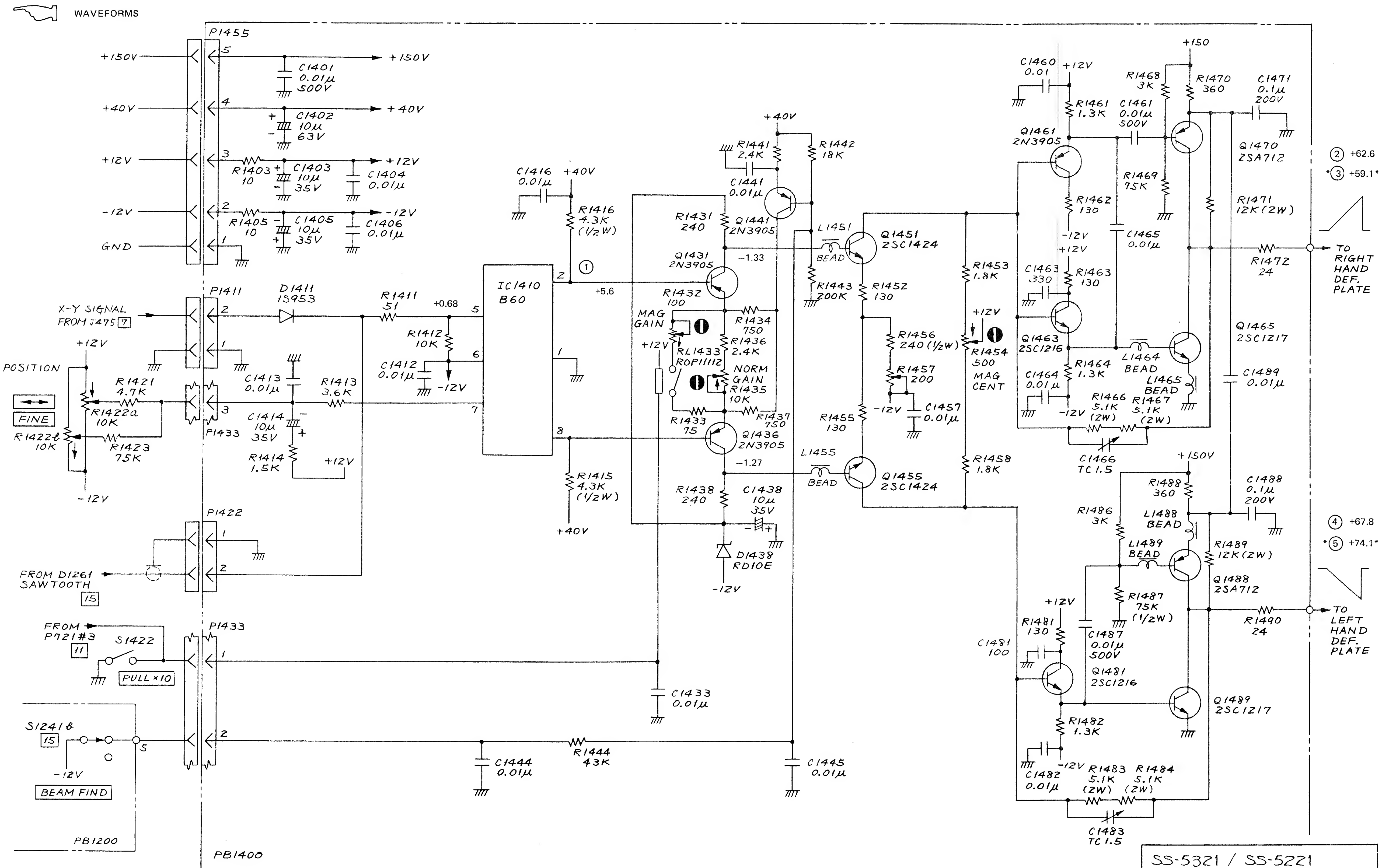
*⑤

120V



≈+130V

5mS

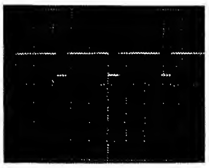


VOLTAGE & WAVEFORM READING CONDITIONS
* FINE (PULL X 10) .... Pull

SS-5321 / SS-5221
HORIZONTAL AMPLIFIER 16

K-606393 | 2

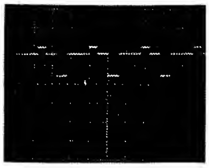
① 24V



≈+8V

5mS

*② 30V



≈+8V

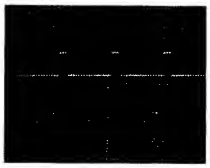
5mS

**③ 32V

≈+8V

5mS

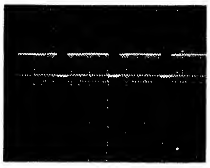
***④ 24V



≈+8V

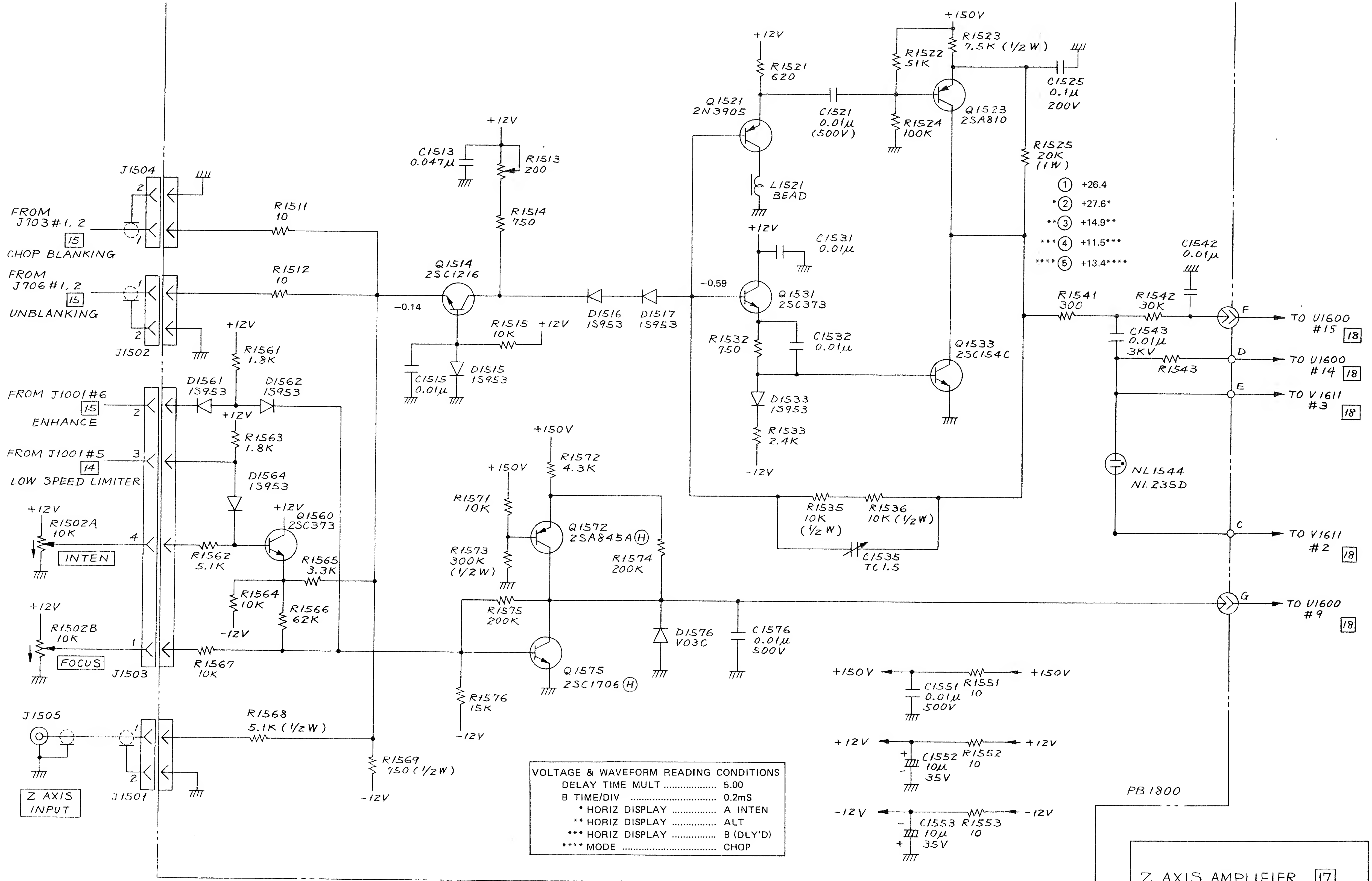
5mS

****⑤ 30V



≈+8V

5mS

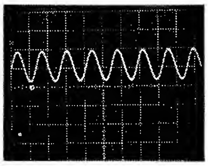


Z AXIS AMPLIFIER 17

K-606394 4

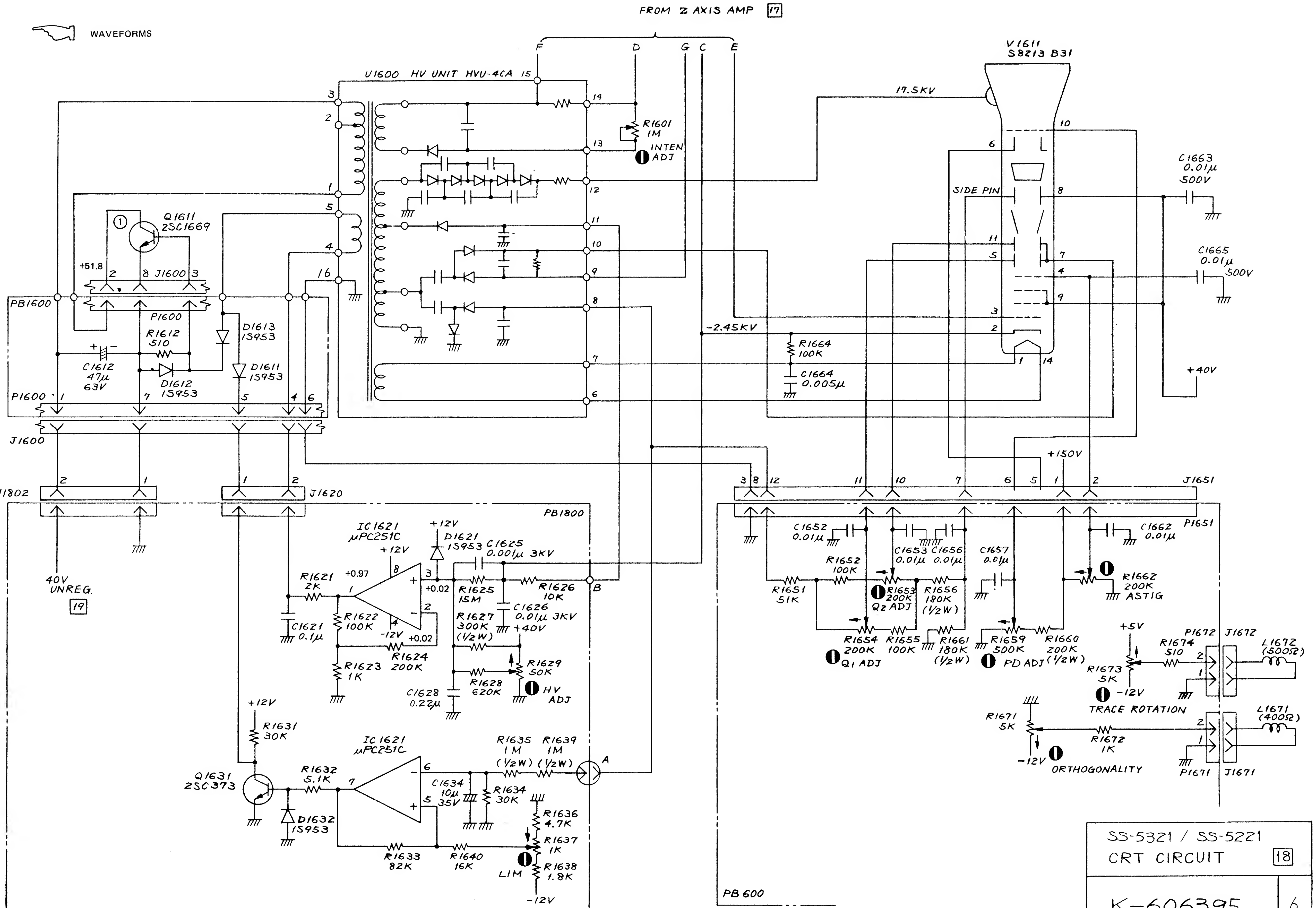
1

80V



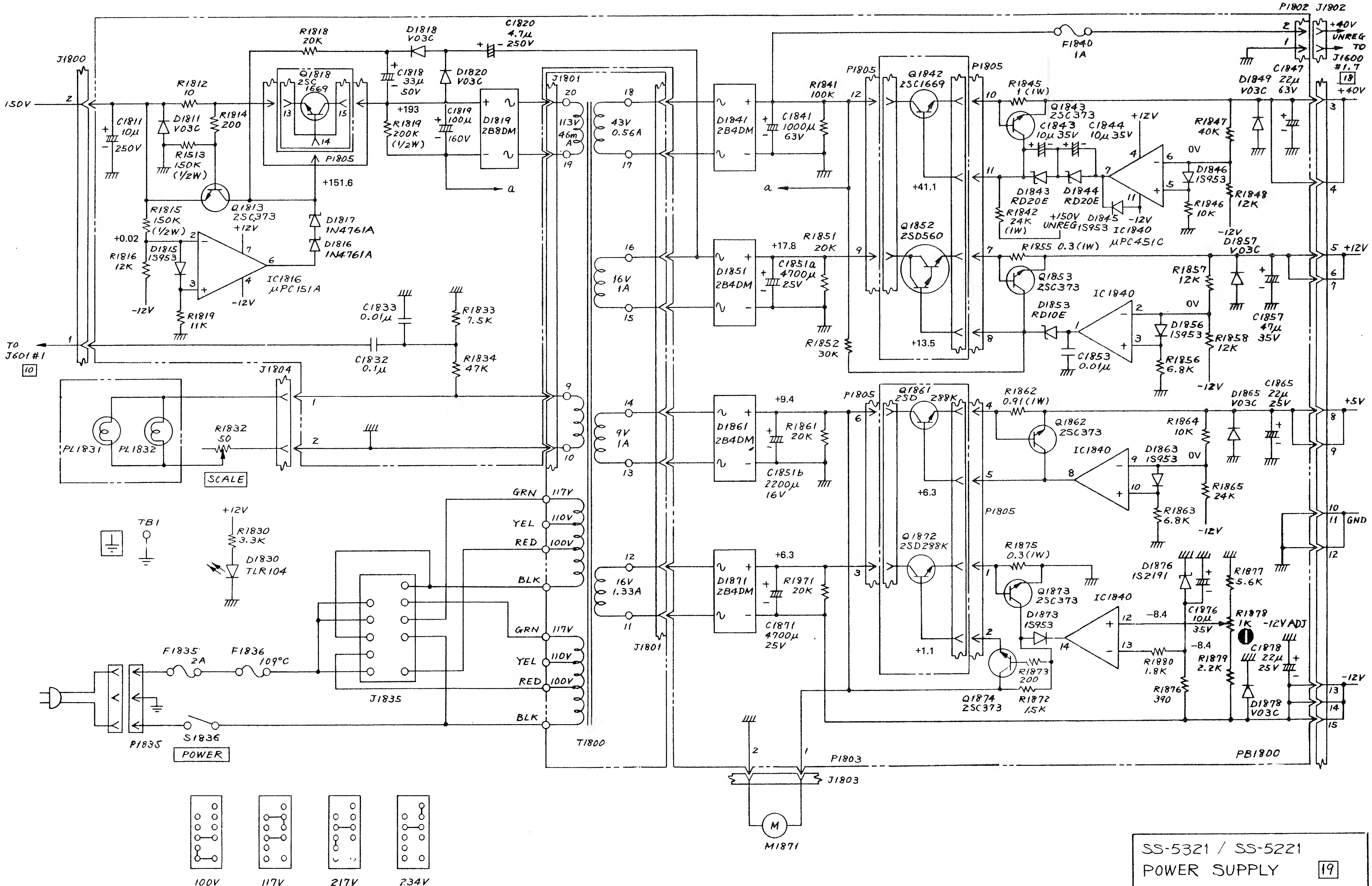
≈+50V

20μS



SS-5321 / SS-5221
CRT CIRCUIT 18

K-606395 6

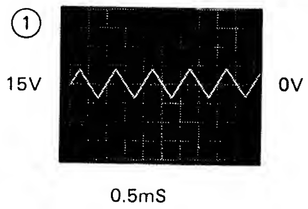


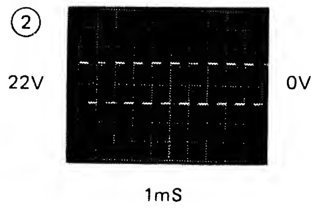
SS-5321 / SS-5221

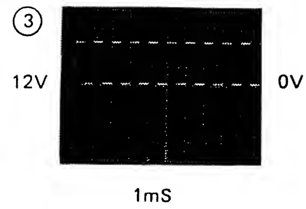
POWER SUPPLY 19

K-606396

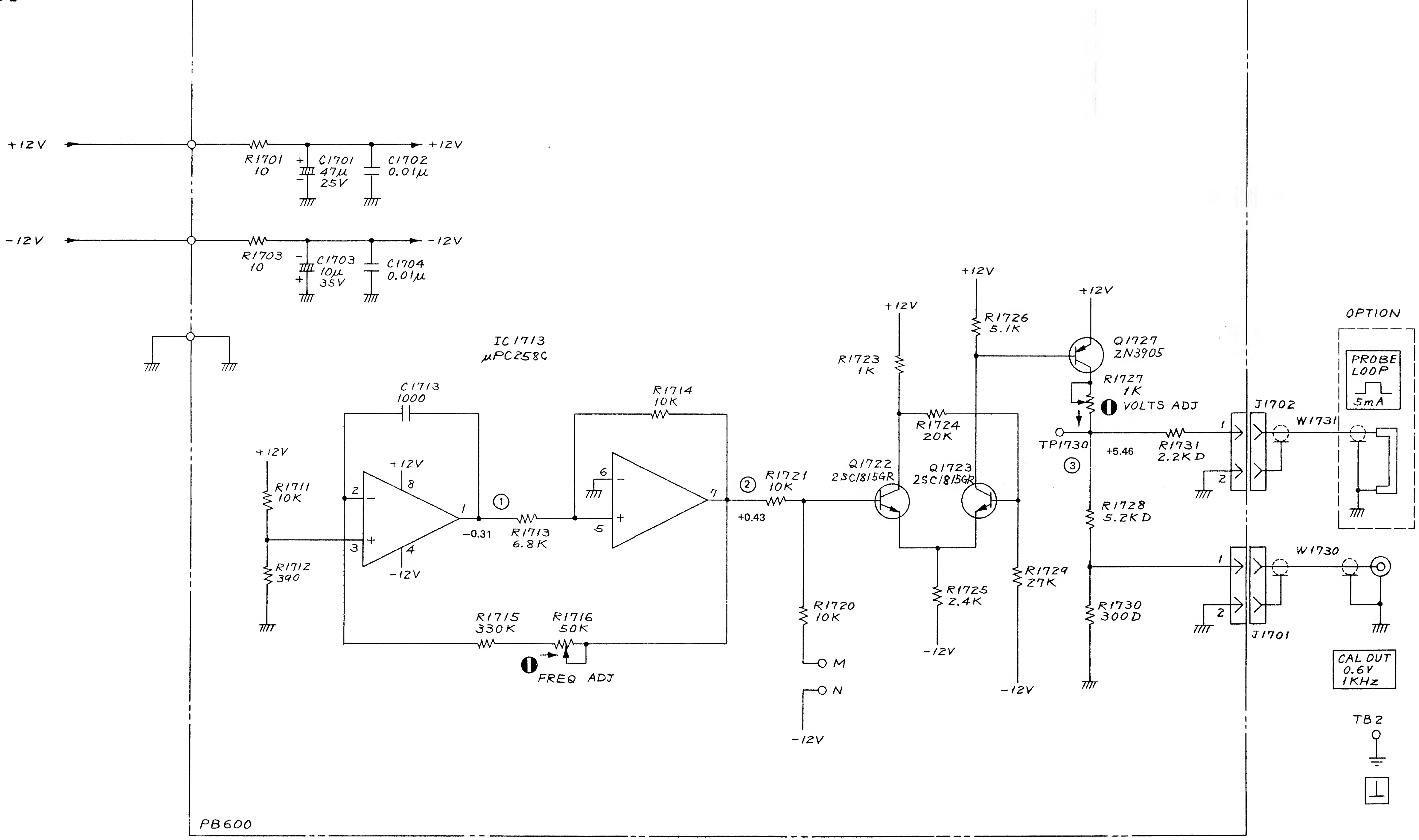
5


1
15V
0V
0.5mS


2
22V
0V
1mS


3
12V
0V
1mS

WAVEFORMS



SS-5321 / SS-5221
CALIBRATOR 20

K-606397 3

SECTION 7
SCHEMATIC DIAGRAMS

Voltages and Waveforms

In the schematic diagrams, the voltages and waveforms in the normal operation of the instrument are shown. These useful for troubleshooting.

The voltage and waveforms are measured according to the following conditions:

1. The CAL 0.6V terminal is connected to the input connector using a 10 : 1 probe for CH3 PREAMPLIFIER) as the test signal.

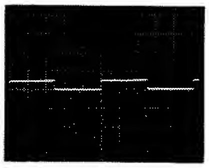
2. The switches and controls of this instrument are set as follows;

POWER	On
INTEN	Mid position
FOCUS	Mid-position
SCALE	Arbitrary position
MODE (Vertical)	CH1
TRI	Out
TRIGGER	CH1
AC-GND-DC (CH1, 2)	DC
VOLTS/DIV (CH1, 2)	10 mV
VARIABLE (CH1, 2)	CALIB
AC-DC (0.1C –1V)	DC-0.1V)
POSITION (CH1, 2, 3)	Adjust to set the waveform to the center of the graticule area.
CH2 POLAR	Out
BANDWIDTH	Out
HORIZ DISPLAY	A
MODE (Sweep)	AUTO
AC-HF REJ-DC	AC
INT-LINE	INT
LEVEL-SLOPE (A)	Push, mid-position
A TIME/DIV	1 mSEC
B TIME/DIV	1 mSEC
A VARIABLE	CALIB
DELAY TIME MULT	Fully counterclockwise
AUTO-TRIG	AUTO
AC-DC	AC
INT-EXT	INT
Horizontal Position	Adjust to set the start point of the waveform to the left end of the graticule area.
FINE (PULL x10)	Push, mid-position
HOLDOFF	Fully counterclockwise
B Sweep Position	Fully counterclockwise

3. Exceptions in the controls setting are shown by "VOLTAGE & WAVEFORM READING CONDITIONS" noted on the schematic diagram. Besides, the asterisks marked on the diagram show the point measured by the exceptional settings.

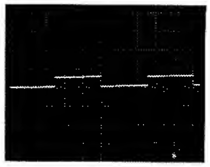
4. The waveforms starting from the negative slope are measured by setting the SLOPE switch of a test oscilloscope to (—).

1

50mV  0V

0.2mS

2

50mV  ≈ +0.25V

0.2mS

3

50mV  ≈ +0.3V

0.2mS

SECTION 8
ELECTRICAL PARTS LIST

Ordering Information

Replacement parts may be ordered through an IWATSU Representative or directly from the factory. To be certain of receiving the proper parts, a ways include the following information with the order:

a. Model Number and serial number of the instrument on which the parts will be installed.
b. Circuit reference number and subassembly name, if applicable, for which the part is intended. If the part does not have a circuit reference, the description from the parts list should be used.
c. Iwatsu part number

For factory repair, contact the IWATSU agent and include the following information.

a. Model number and serial number of the instrument on which the work is to be performed.
b. Details concerning the nature of the malfunction, or, type of repair desired.
Shipping instructions will be sent to you promptly.

How to use This Parts List

The parts list is divided into subsections corresponding to the schematic diagrams such as VERTICAL AMP, TRIG CIRCUIT, SWEEP GENERATOR, HORIZONTAL AMP. CRT CIRCUIT and POWER SUPPLY. Component locations can be determined from the schematic diagrams, each component appears only once in the parts list. At the beginning of each subsection are listed part numbers for any complete subassemblies in that category that are available as replacement parts. These subassemblies may include individually-listed components; care should be taken to pin point malfunctions to the exact replacement parts actually needed and thus avoid the time and cost involved in "over-repair".

Abbreviations

Cap . . . . Capacitor
    Cer. . . . . Ceramic
    Poly. . . . . . . Polyethytel film
    Elect. . . . . . Aluminium electrolytic chemical
    Elect. tan . . . Tan-talum electrolytic chemical condenser
    [The symbol F (farad) is omitted]
Res. . . . . Resistor
    W.W. . . . . . . Wire wound
    Comp. . . . . . Composition
    [The symbol Ω (ohm) is omitted]
FET . . . . Field Effect Transistor
Diode . . . .
    T. diode . . . . Tunnel diode
    Z. diode . . . . Zenner diode
    S.B. diode . . Schottky barrier diode
    V.C. diode . . Variable capacitance diode
    L.E.diode . . . Light emission diode
Var. . . . . Variable

CKT. NO.	DESCRIPTION	IWATSU PART NO.	CKT. NO.	DESCRIPTION	IWATSU PART NO.
CH1 & CH2 PREAMPLIFIER (1)			R23A/B	Res., 75, ±5%, 1/8W, Compo.	DRC122481
			R40A/B	Res., 900K, ±0.5%, 1/2W, Metal	DRE243871
C1 A/B	Cap., 0.047μ, ±10%, 600V, Plastic	DCF171131	R41A/B	Res., 510K, ±5%, 1/4W, Compo.	DRC133401
C2 A/B	Cap., 10p, ±1%, 50V, Cer.	DCC231701	R43A/B	Res., 470, ±5%, 1/8W, Compo.	DRC122671
C3 A/B	Cap., Max. 1.5p, Plastic	DCV023121	R44A/B	Res., 43, ±5%, 1/4W, Carbon	DRD130501
C4 A/B	Cap., 7p, ±0.5%, 50V, Cer.	DCC231101	R46A/B	Res., 43, ±1%, 1/8W, Metal	DRE520401
C5 A/B	Cap., 62p, ±5%, 500V, Cer.	DCC253501	R47A/B	Res., 100, ±1%, 1/8W, Metal	DRE520471
C10 A/B	Same as C3 A/B		R48A/B	Same as R46A/B	
C11 A/B	Cap., 3p, ±0.5%, 50V, Cer.	DCC230701	R50A/B	Same as R47A/B	
C13 A/B	Cap., 3.5 ~ 10p, Var., 250V, Cer.	DCV011121	R51A/B	Res., 5.1K, ±1%, 1/8W, Metal	DRE520621
C20 A/B	Same as C3 A/B		R52A/B	Res., 5K, ±20%, 1/8W, Cermet	DRV411071
C21 A/B	Cap., 100p, ±10%, 45V, Mica	DCM343211	R53A/B	Res., 2.2K, ±2%, 1/4W, Metal	DRE939021
C23 A/B	Same as C13 A/B		R54A/B	Same as R53A/B	
C41 A/B	Cap., 1000p, +100 −0%, 500V, Cer.	DCC151801	R55A/B	Res., 300, ±1%, 1/8W, Metal	DRF520521
C43 A/B	Cap., Max. 1.5p, Plastic	DCV023121	R60A/B	Res., 30, ±1%, 1/8W, Metal	DRE520391
C44 A/B	Cap., 0.01μ, +80 −20%, 50V, Cer.	DCC133571	R61A/B	Same as R60A/B	
C45 A/B	Cap., 1000p, +80 −20%, 50V, Cer.	DCC131801	R62A/B	Res., 47, ±1%, 1/8W, Metal	DRE520651
C46 A/B	Cap., 75p, ±5%, 50V, Cer.	DCC233701	R63A/B	Same as R62A/B	
C48 A/B	Same as C45 A/B		R64A/B	Res., 36, ±5%, 1/4W, Compo.	DRC132401
C53A	Same as C44 A/B		R65A/B	Res., 62, ±5%, 1/4W, Compo.	DRC132461
C54 A	Same as C44 A/B		R66A/B	Res., 91, ±5%, 1/4W, Compo.	DRC132501
C64 A	Cap., 7p, ±0.5%, 50V, Cer.	DCC231501	R67A/B	Res., 8.2K, ±5%, 1/4W, Carbon	DRD139581
C64 B	Cap., 10P, ±0.5P, 50V, Cer.	DCC231701	R70A/B	Res., 820, ±1%, 1/8W, Metal	DRE535471
C65 A/B	Cap., 2p, ±0.5%, 50V, Cer.	DCC230501	R71A/B	Same as R70A/B	
C67 A/B	Cap., 1000p, ±10%, 50V, Plastic	DCF120111	R72A/B	Res., 300, ±1%, 1/8W, Metal	DRE535361
C78 A/B	Cap., 6p, ±0.5%, 50V, Cer.	DCC231001	R73A/B	Same as R72A/B	
C80 A/B	Cap., 2p, ±0.5%, 50V, Cer.	DCC230501	R74A/B	Res., 510, ±2%, 1/4W, Metal	DRE939131
C82 A/B	Cap., 8p, ±0.5%, 50V, Cer.	DCC231301	R75A/B	Same as R74A/B	DRE133661
C87 A/B	Same as C82 A/B		R76A/B	Res., 62, ±1%, 1/8W, Metal	DRE520431
C90 A/B	Cap., 4p, ±0.5%, 50V, Cer.	DCC230801	R77A/B	Same as R76A/B	
C91 A/B	Same as C80 A/B		R78A/B	Res., 150, ±5%, 1/4W, Compo.	DRC132551
			R80A/B	Same as R47A/B	
R2A/B	Res., 75, ±5%, 1/4W, Compo.	DRC132481	R81A/B	Same as R47A/B	
R3A/B	Res., 470, ±5%, 1/8W, Compo.	DRC122671	R82A/B	Res., 100, ±5%, 1/4W, Compo.	DRC132511
R4A/B	Res., 56, ±5%, 1/4W, Compo.	DRC132451	R83A/B	Same as R52A/B	
R5A/B	Res., 100K, ±0.5%, 1/4W, Carbon	DRE234011	R84A/B	Res., 1.6K, ±1%, 1/4W, Metal	DRE535541
R10A/B	Res., 900K, ±0.5%, 1/2W, Carbon	DRE243871	R85A/B	Res., 500, ±20%, 0.5W, Cermet	DRV411041
R11A/B	Res., 111K, ±0.5%, 1/4W, Carbon	DRE233941	R86A/B	Same as R84A/B	
R12A/B	Res., 100, ±5%, 1/8W, Compo.	DRD134591	R87A/B	Res., 200, ±5%, 1/4W, Compo.	DRC132581
R13A/B	Res., 43, ±5%, 1/8W, Compo.	DRC122421	R90A/B	Same as R47A/B	
R20A/B	Res., 990K, ±0.5%, 1/2W, Carbon	DRE243901	R91A/B	Same as R47A/B	
R21A/B	Res., 10.1K, ±0.5%, 1/4W, Carbon	DRE233611	R92A/B	Same as R52A/B	
R22A/B	Res., 62, ±5%, 1/8W, Compo.	DRD134551	R93A/B	Same as R84A/B	

CKT. NO.	DESCRIPTION	IWATSU PART NO.
R94A/B	Same as R85A/B	
R95A/B	Same as R84A/B	
D41A/B	Diode, 1S1544A	DDD010801
D48A/B	Z. Diode, RD5.1E	DDD030571
D48B	Diode RD5.1EB, TA21R	DDD030601
Q40A/B	FET, 2N5912	DTR155311
Q50A/B	Transistor, 2SC1733	DTR137031
IC60A/B	Integrated circuit, A44	DIC810441
IC90A/B	Integrated circuit, B99	DIC820991
S1A/B	Lever Switch, LS18H 1-2-3	DSW045511
S2A/B	Rotary Switch, S15M 3-6-10 S_2 /RV	DSW034484
J1A/B	BNC Connector, BNC-BR-226	DCN040111

CKT. NO.	DESCRIPTION	IWATSU PART NO.
CH1 & CH2	**PREAMPLIFIER (2)**	
C138B	Cap., 4p, ±0.25%, 50V, Cer.	DCC230801
C140A	Cap., 3p, ±0.25%, 50V, Cer.	DCC230701
C140B	Same as C138B	
C141A/B	Cap., 1000p, +80 −20%, 50V, Cer.	DCC131801
C146A	Cap., 0.01μ, +80 −20%, 50V, Cer.	DCC133571
C150B	Same as C146A	
C151B	Same as C146A	
C153B	Cap., 1.5p, ±10%, 50V, Cer.	DCC230401
C154	Cap., 1p, ±0.25%, 50V, Cer.	DCC230301
C160A/B	Cap., 10μ, ±20%, 35V, Elect. Tan.	DCS471301
C161B	Same as C146A	
C162A/B	Same as C146A	
C163A	Cap., 22μ, +100 −10%, 25V, Elect.	DCE222551
C177A	Cap., 7p, ±0.5%, 50V, Cer.	DCC231101
C178A/B	Cap., 2200p, ±10%, 50V, Plastic	DCF120151
C179A	Cap., 91p, +80 −20%, 50V, Cer.	DCC233801
C179B	USD05SL 680J	DCC233601
C180A/B	Same as C146A	
C184A/B	Cap., 10p, ±1%, 50V, Cer.	DCC231701
C190A/B	Cap., 5p, Var., 50V, Cer.	DCV010211
C191A/B	Cap., 10p, Var., 50V, Cer.	DCV010221
C192A/B	Same as C191A/B	
C193A/B	Cap., 5p, 10%, 50V, Cer.	DCC230901
C194A/B	Same as C193A/B	
C195A/B	Cap., 220μ, ±20%, 6.3V, Elect.	DCE910091
C196A/B	Cap., 10μ, ±20%, 6.3V, Elect.	DCE910071
C197A/B	Cap., 1μ, ±20%, 50V, Elect.	DCE940581
C198A/B	Cap., 0.1μ, ±10%, 50V, Plastic	DCF120351
C199A/B	Cap., 0.022μ, ±10%, 50V, Plastic	DCF120271
C211A	Cap., 8p, ±10%, 50V, Cer.	740505600
C240B	Same as C193A/B	
R130A/B	Res., 30, ±1%, 1/8W, Metal	DRE520391
R131A/B	Same as R130A/B	
R132A/B	Res., 500V, Var., 1/2W, Cermet	743493135
R133A/B	Res., 1.1K, ±2%, 1/4W, Metal	DRE133741
R134A/B	Same as R132A/B	
R135A/B	Same as R133A/B	
R136A/B	Res., 330, ±1%, 1/8W, Metal	DRE520531
R137A/B	Res., 500, Var., 1/2W, Cermet	DRV411041
R138B	Res., 100, ±5%, 1/4W, Compo.	DRC132511

CKT. NO.	DESCRIPTION	IWATSU PART NO.	CKT. NO.	DESCRIPTION	IWATSU PART NO.
R140A/B	Res., 51, ±5%, 1/4W, Compo.	DRC132441	R191A/B	Same as R132A/B	
R141A	Same as R140A/B		R193A/B	Same as R180A/B	
R141B	Res., 160, ±5%, 1/4W, Compo.	DRC132561	R194A/B	Same as R180A/B	
R142A/B	Res., 390, ±5%, 1/4W, Carbon	DRD139351	R195A	Same as R177A	DRD139461
R143A/B	Res., 10K, ±5%, 1/4W, Carbon	DRD138921	R195B	Res., 2.2, ±5%, 1/4W, Carbon	DRD130911
R144A	Res., 750, ±2%, 1/4W, Metal	DRE133701	R196A	Res., 3.3K, ±5%, 1/4W, Carbon	DRD139501
R145A	Res., 110, ±2%, 1/4W, Metal	DRE133501	R196B	Res., 3.3K, ±1%, 1/4W, Metal	DRE535611
R146A/B	Res., 5K, Var., 0.125W, Carbon	DRV147091	R197A/B	Res., 2.4K, ±5%, 1/4W, Carbon	DRE535581
R147B	Res., 750, ±5%, 1/4W, Carbon	DRD130801	R198A	Res., 4.3K, ±5%, 1/4W, Carbon	DRE535641
R150A/B	Res., 910, ±2%, 1/4W, Metal	DRE939281	R198B	Res., 4.3K, ±5%, 1/4W, Carbon	DRD139951
R151A/B	Res., 300, ±2%, 1/4W, Metal	DRE133601	R199A/B	Res., 4.7K, ±5%, 1/4W, Carbon	DRD139151
R152B	Res., 100, Var., 1/2W, Cermet	743493142	R201A/B	Res., 1.5K, ±2%, 1/4W, Metal	DRE133771
R153B	Res., 200, ±5%, 1/4W, Metal	DRC132581	R202A/B	Res., 820, ±2%, 1/4W, Metal	DRE939151
R154B	Res., 75, ±5%, 1/4W, Carbon	DRD130561	R210A/B	Res., 430, ±5%, 1/4W, Carbon	DRD130741
R160A/B	Res., 200, ±5%, 1/4W, Carbon	DRD139311	R211A	Res., 20, ±5%, 1/4W, Compo.	DRC132341
R161A/B	Res., 2K, ±5%, 1/4W, Carbon	DRD139451	R221A/B	Res., 1.6K, ±2%, 1/4W, Metal	DRE133781
R162A/B	Res., 20K, ±5%, 1/4W, Carbon	DRD138981	R222A/B	Same as R221A/B	
R163A	Res., 240, ±5%, 1/4W, Carbon	DRD138801	R223A/B	Same as R147B	
R163B	Res., 240, ±5%, 1/4W, Carbon	DRD130681	R224A/B	Same as R147B	
R164A/B	Same as R144A/B		R225A/B	Res., 680, ±5%, 1/4W, Carbon	DRD139391
R165A/B	Res., 390, ±2%, 1/4W, Metal	DRE133631	R227A/B	Res., 5K, Var., 0.125W, Carbon	DRV147041
R170A/B	Res., 20, ±1%, 1/8W, Metal	DRE520381	R228A/B	Res., 5K, Var., 1/2W, Cermet	DRV411071
R171A/B	Same as R170 A/B		R229A	Res., 39K, ±2%, 1/4W, Metal	DRE939321
R172A	Res., 82, ±1%, 1/8W, Metal	DRE520461	R240A/B	Same as R170A/B	
R172B	Res., 91, ±1%, 1/8W, Metal	DRE520741	R241A/B	Same as R170A/B	
R173A/B	Res., 2K, Var., 1/2W, Cermet	DRV411061	R242A/B	Res., 150, ±1%, 1/8W, Metal	DRE520491
R174A	Same as R172A		R243A/B	Same as R242A/B	
R174B	Same as R172B		R244A/B	Res., 68, ±2%, 1/4W, Metal	DRE133451
R175A	Same as R170A/B		R245A/B	Res., 6.2K, ±5%, 1/4W, Carbon	DRD139551
R175B	Res., 10, ±1%, 1/8W, Metal	DRE520351	R246A/B	Res., 91, ±5%, 1/4W, Carbon	DRD130581
R176A	Same as R170A/B				
R176B	Same as R175B		D146B	L.E. Diode, TLR104	DDD070301
R177A	Res., 1.3K, ±5%, 1/4W, Carbon	DRD138751	D147A	Diode, 1S953	DDD010821
R178A/B	Res., 1.1K, ±5%, 1/4W, Carbon	DRE535501	D160A/B	Z. Diode, RD3.9E	DDD032921
R179A/B	Same as R137A/B		D160B	Z. Diode, RD3.9E	DDD030951
R180A/B	Res., 51, ±1%, 1/8W, Metal	DRE520421			
R181A/B	Same as R180 A/B		Q160A/B	Transistor, 2SA495	DTR116111
R182A/B	Same as R180 A/B		Q180A/B	Transistor, 2SC1254	DTR130861
R183A/B	Same as R180A/B		Q182A/B	Same as Q180A/B	
R184A/B	Same as R180A/B		Q240A/B	Transistor, 2SC1216	DTR130791
R185A/B	Res., 680, ±5%, 1/4W, Carbon	DRD139391			
R186A/B	Same as R185A/B		IC140A/B	Integrated circuit, A45	DIC810451
R187A/B	Same as R137A/B		IC160	Integrated circuit, μPC451C	DIC610101
R190A/B	Same as R152B		IC190A/B	Integrated circuit, A43	DIC810431
			IC220A/B	Integrated circuit, B100	DIC821001

CKT. NO.	DESCRIPTION	IWATSU PART NO.
DELAY CABLE DRIVER		
C260	Cap., 68p, ±5%, 50V, Cer.	DDC233601
C290	Cap., 20p, ± 5%, 50V, Cer.	DCC232301
C291	Cap., 15p, Var., 50V, Cer.	DCV010231
C292	Cap., 5p, Var., 50V, Cer.	DCV010211
C293	Cap., 4p, ±10%, 50V, Cer.	DCC230801
C310	Cap., 75p, ±5%, 50V, Cer.	DCC233701
C320	Cap., 47μ, +100 −10%, 25V, Elect.	DCL150442
C321	Cap., 47μ, +100 −10%, 16V, Elect.	DCE222651
C322	Same as C320	
L310	Inductor, Coil	DCC233701
L311	Same as L310	
L320	Inductor, Coil	DCL150442
L321	Same as L320	
L322	Same as L320	
R250	Res., 30, ±1%, 1/8W, Metal	DRE520391
R251	Same as R250	
R252	Res., 62, ±1%, 1/8W, Metal	DRE520431
R253	Same as R252	
R261	Res., 5K, Var., 1/2W, Cermet	DRV411071
R262	Res., 360, ±2%, 1/4W, Metal	DRE133621
R263	Same as R262	
R270	Res., 20, ±1%, 1/8W, Metal	DRE520381
R271	Same as R270	
R273	Res., 330, ±2%, 1/2W, Metal	DRE143611
R274	Res., 500, ±20%, at 25°C	DDD080241
R275	Res., 300, ±1%, 1/8W, Metal	DRE520521
R276	Res., 510, ±5%, 1/4W, Carbon	DRD130761
R282	Res., 51, ±1%, 1/8W, Metal	DRE520421
R283	Same as R282	
R290	Res., 10K, ±15%, at 25°C	DDD080431
R291	Res., 4.7K, ±5%, 1/4W, Carbon	DRD130991
R292	Res., 20K, ±5%, 1/4W, Carbon	DRD138981
R293	Res., 500, Var., 1/2W, Cermet	DRV411041
R294	Res., 100, Var., 1/2W, Cermet	DRV411021
R295	Res., 56, ±5%, 1/4W, Compo.	DRC132451
R300	Res., 120, ±5%, 1/4W, Carbon	DRD139301
R301	Same as R300	
R302	Res., 270, ±5%, 1/4W, Carbon	DRD139331
R303	Res., 1.8K, ±5%, 1/4W, Carbon	DRD139441

CKT. NO.	DESCRIPTION	IWATSU PART NO.
R304	Same as R303	
R305	Res., 1K, Var., 1/2W, Cermet	DRV411051
R306	Res., 910, ±5%, 1/4W, Carbon	DRD139411
R307	Same as R306	
D280	V.C. Diode, 1S1922D	DDD990111
D281	V.C. Diode, 1S1924	DDD010391
D282	Same as D280	
D283	Same as D280	
Q250	Transistor, 2SC2148	DTR137061
Q252	Same as Q250	
Q300	Transistor, 2N5771	DTR115301
Q310	Same as Q300	
S310	Push Switch, KSD 1-4-0 LLDC	DSW014061
DL300	Delay Line, VDL-2X 1/0.8 100Ω	KHB043011
J290	Connector, (IC Socket) IC-09-14	DSK045001
J300	Connector, 65039-033	DCN033111
J315	Connector, 65039-035	DCN033131
J316	Same as J315	
P300	Connector, 65532-X36	DCN033501
P315	Same as P300	DCN033501
P316	Same as P300	DCN033501

CKT. NO.	DESCRIPTION	IWATSU PART NO.
CH3 PREAMPLIFIER		
C323	Cap., 3 ~ 7p, Var., 250V, Cer.	DCV011111
C324	Same as C323	
C325	Cap., 43p, ±20%, 50V, Cer.	DCC233111
C326	Same as C323	
C327	Cap., 0.047μ, ±20%, 600V, Plastic	DCF171131
C329	Cap., 1p, ±20%, 500V, Cer.	DCC250301
C330	Cap., 3.5 ~ 10p, Var., 250V, Cer.	DCV011121
C331	Cap., 6p, ±0.05%, 50V, Cer.	DCC231001
C332	Cap., 10p, ±10%, 500V, Cer.	DCC251701
C335	Cap., 1000p, +80 −20%, 50V, Cer.	DCC131801
C336	Same as C335	
C337	Cap., 75p, ±5%, 50V, Cer.	DCC233701
C350	Cap., 4 ~ 10p, Var., 50V, Cer.	DCV010221
C354	Cap., 0.01μ, ±10%, 50V, Plastic	DCF120231
C355	Cap., 27p, ±5%, 50V, Cer.	DCC232501
C356	Cap., 10p, ±5%, 50V, Cer.	DCC231701
C367	Same as C355	
C370	Same as C335	
C378	Same as C355	
C383	Same as C350	
C384	Cap., 30p, ±5%, 50V, Cer.	DCC232701
C385	Same as C335	
C386	Same as C335	
C387	Same as C335	
C388	Cap., 10p, ±0.5%, 50V, Cer.	DCC231701
C389	Same as C367	
C390	Cap., 6p, ±0.5%, 50V, Cer.	DCC231001
C391	Same as C390	
L360	Inductor, Ferrite Bead Core	DCL320251
L362	Same as L360	
R322	Res., 43, ±5%, 1/8W, Compo.	DRC122421
R323	Res., 900K, ±0.5%, 1/2W, Metal	DRE243871
R324	Same as R322	
R325	Res., 111K, ±0.5%, 1/4W, Metal	DRE233941
R326	Res., 150, ±5%, 1/8W, Compo.	DRC122551
R328	Res., 30, ±5%, 1/8W, Compo.	DRC122381
R329	Res., 430, ±5%, 1/4W, Compo.	DRC132661
R330	Res., 750K, ±0.5%, 1/2W, Metal	DRE244041
R331	Res., 51, ±5%, 1/4W, Compo.	DRC132441

CKT. NO.	DESCRIPTION	IWATSU PART NO.
R335	Res., 250K, ±0.5%, 1/2W, Metal	DRE244001
R336	Res., 43, ±5%, 1/4W, Carbon	DRD130501
R337	Res., 43, ±1%, 1/8W, Metal	DRE520401
R338	Res., 100, ±1%, 1/8W, Metal	DRE520471
R339	Same as R337	
R341	Res., 100, ±2%, 1/4W, Metal	DRE133491
R342	Res., 5.1K, ±2%, 1/4W, Metal	DRE133901
R343	Res., 5K, ±20%, 1/2W, Cermet	DRV411071
R350	Same as R337	
R351	Res., 100, ±20%, 1/2W, Cermet	DRV411021
R352	Res., 1.6K, ±2%, 1/4W, Metal	DRE133781
R353	Same as R352	
R354	Res., 8.2K, ±1%, 1/4W, Metal	DRE535711
R355	Res., 750, ±5%, 1/4W, Carbon	DRD130801
R356	Res., 200, ±5%, 1/4W, Compo.	DRC132581
R357	Res., 10, ±5%, 1/4W, Carbon	DRD130351
R360	Res., 620, ±2%, 1/4W, Metal	DRE133681
R362	Same as R360	
R365	Res., 510, ±2%, 1/4W, Metal	DRE939131
R366	Same as R365	
R367	Same as R341	
R370	Res., 330, ±2%, 1/4W, Metal	DRE133611
R371	Res., 51, ±1%, 1/8W, Metal	DRE520421
R372	Same as R371	
R373	Same as R371	
R374	Same as R371	
R375	Res., 62, ±1%, 1/8W, Metal	DRE520431
R376	Res., 910, ±5%, 1/4W, Carbon	DRD139411
R377	Same as R376	
R378	Res., 51, ±5%, 1/4W, Compo.	DRC132441
R380	Res., 75, ±5%, 1/4W, Carbon	DRD130561
R381	Res., 330, ±5%, 1/4W, Carbon	DRD139351
R382	Same as R380	
R383	Same as R351	
R384	Res., 75, ±5%, 1/4W, Compo.	DRC132481
R385	Same as R355	
R386	Same as R355	
R387	Res., 500, Var., 0.1W, Carbon	DRV130361
R390	Res., 91, ±5%, 1/4W, Carbon	DRD130581
R391	Res., 6.2K, ±5%, 1/4W, Carbon	DRD139551
R392	Res., 820, ±2%, 1/4W, Metal	DRE939151
R393	Res., 1.5K, ±2%, 1/4W, Metal	DRE133771

CKT. NO.	DESCRIPTION	IWATSU PART NO.
D335	Diode, 1S1544A	DDD010801
D337	Diode, 1S953	DDD010051
D338	Same as D337	
D339	Z. Diode, RD5.1E	DDD030571
D390	Diode, 1SS16	DDD010411
D391	Same as D390	
IC380	Integrated circuit, A-43	DIC810431
Q335	Transistor, 2N5912	DTR250011
Q350	Transistor, 2SC1424	DTR136931
Q352	Same as Q350	
Q360	Transistor, 2N5771	DTR115301
Q362	Same as Q360	
Q373	Transistor, 2SC1254	DTR130861
Q374	Same as Q373	
Q385	Transistor, 2SC1216	DTR130791
S320	Lever Switch, LS18H 1-2-4	DSW045521
J320	BNC Connector, BNC-BR-226	DCN040111

TRIGGER AMPRIFIER

CKT. NO.	DESCRIPTION	IWATSU PART NO.
C420	Cap., 9p, ±0.5%, 50V, Cer.	DCC231501
C422	Cap., 15p, ±10%, 50V, Cer.	DCC231001
C425	Same as C422	
C430	Cap., 0.01μ, +80 −20%, 50V, Cer.	DCC133571
C431	Same as C430	
C432	Same as C430	
C444	Cap., 10μ, ±0.5%, 6.3V, Elect.	DCE910071
C445	Cap., 100p, ±5%, 50V, Cer.	DCC233801
C449A	Cap., 220μ, ±0.5%, 6.3V, Elect.	DCE910091
C449B	Cap., 0.022μ±10%, 50V, Plastic	DCE120271
C449C	Cap., 2200p, ±10%, 50V, Plastic	DCF120151
C450	Cap., 1000p, +80 −20%, 50V, Cer.	DCC131801
C463	Cap., 10μ, ±20%, 35V, Elect. Tan.	DSC471301
L401	Inductor, Ferrite Bead Core L82OP -03·03-1H	DCL320251
L402	Same as L401	
L403	Same as L401	
L404	Same as L401	
L405	Same as L401	
L406	Same as L401	
L432	Same as L401	
L465	Inductor, Ferrite Core L82OR-10.3-4H	745601040
L466	Same as L465	
L480	Same as L465	
R410	Res., 390, ±5%, 1/4W, Carbon	DRD139361
R411	Same as R410	
R420	Res., 30, ±1%, 1/8W, Metal	DRE520391
R421	Res., 300, ±2%, 1/2W, Carbon	DRE143601
R422	Same as R420	
R423	Res., 240, ±5%, 1/4W, Carbon	DRD138801
R424	Same as R423	
R425	Same as R420	
R440	Res., 300, ±5%, 1/4W, Carbon	DRD139341
R441	Same as R440	
R442	Res., 68, ±1%, 1/8W, Metal	DRE520441
R443	Res., 100, ±20%, 1/2W, Cermet	DRV411021
R444	Res., 820, ±5%, 1/4W, Carbon	DRD139941
R445	Res., 470, ±2%, 1/4W, Metal	DRE939121
R446	Same as R445	
R447	Same as R440	

CKT. NO.	DESCRIPTION	IWATSU PART NO.
R448	Res., 500, ±20% at 25°C	DDD080241
R449A	Res., 1.3K, ±5%, 1/4W, Carbon	DRD130861
R449B	Res., 2.2K, ±5%, 1/4W, Carbon	DRD130911
R449C	Res., 3K, ±5%, 1/4W, Carbon	DRD130941
R450	Same as R423	
R451	Res., 240, ±2%, 1/4W, Metal	DRE133581
R452	Res., 1.5K, ±2%, 1/4W, Metal	DRE133771
R453	Res., 2K, ±20%, 1/2W, Cermet	DRV411061
R454	Res., 6.2K, ±2%, 1/4W, Metal	DRE133921
R455	Res., 150, ±5%, 1/4W, Carbon	DRD130631
R460	Same as R449C	
R461	Res., 560, ±2%, 1/4W, Metal	DRE939141
R462	Res., 1K, ±20%, 1/2W, Cermet	DRV411051
R463	Same as R423	
R464	Res., 1.5K, ±5%, 1/4W, Carbon	DRD139431
R465	Res., 51, ±5%, 1/4W, Carbon	DRD138841
R466	Res., 10K, ±5%, 1/4W, Carbon	DRD139161
R470	Same as R464	
R471	Same as R464	
R472	Res., 3.9K, ±5%, 1/4W, Carbon	DRD139521
R474	Res., 1K, ±2%, 1/4W, Metal	DRE939071
R475	Res., 5K, ±20%, 1/2W, Cermet	DRV411071
D410	Diode, 1S953	DDD010051
D411	Same as D410	
D450	Same as D410	
D451	Same as D410	
D452	Same as D410	
D470	Same as D410	
Q410	Transistor, 2SC1424	DTR136931
Q412	Same as Q410	
Q470	Transistor, 2SC373	DTR137781
IC401	Diode Array, B2	DIC821221
IC402	Same as IC401	
IC450	Transistor Array, FT5709M	DTR190331
J420	Connector, 65039-033 (4P)	DCN034921
J465	Connector, 65039-035 (2P)	DCN033131
J475	Same as J465	
J480	BNC Connector, BNC-BR-226	DCN040711
P420	Connector, 65532-X36 (4Px1)	DCN034921
P465	Same as P420	
P475	Same as P420	

CKT. NO.	DESCRIPTION	IWATSU PART NO.
VERTICAL SWITCHING LOGIC		
C530	Cap., 100p, ±10%, 50V, Cer.	DCC239081
C531	Same as C530	
C540	Cap., 470p, ±10%, 50V, Cer.	DCC235301
C560	Cap., 0.01μ, ±10%, 50V, Cer.	DCC133571
C561	Same as C560	
C562	Same as C560	
C570	Same as C560	
C571	Same as C560	
C572	Same as C560	
C580	Cap., 10μ, +100 −10%, 25V, Elect.	DCE225181
C581	Cap., 47μ, +100 −10%, 16V, Elect.	DCE220651
C582	Same as C580	
L501	Inductor, Coil	DCL150442
R503.	Res., 330, ±5%, 1/4W, Carbon	DRD139351
R530	Res., 12K, ±2%, 1/4W, Metal	DRE133991
R531	Res., 1.8K, ±2%, 1/4W, Metal	DRE939121
R532	Same as R530	
R533	Same as R531	
R540	Res., 1K, ±5%, 1/4W, Carbon	DRD139141
R541	Res., 560, ±5%, 1/4W, Carbon	DRD139171
R542	Same as R540	
R550	Res., 2K, ±2%, 1/4W, Metal	DRE939011
R551	Same as R531	
R552	Res., 2.4K, ±2%, 1/4W, Metal	DRE133821
R553	Same as R550	
R554	Same as R531	
R555	Same as R552	
R560	Same as R550	
R561	Same as R531	
R562	Same as R552	
D520	Diode, 1N34A	DDD010101
D521	Diode, 1S953	DDD010821
D522	Same as D521	
D523	Same as D521	
D530	Same as D521	
D531	Same as D521	
D532	Same as D521	
D533	Same as D521	

CKT. NO.	DESCRIPTION	IWATSU PART NO.
D534	Same as D521	
D535	Same as D521	
D536	Same as D521	
D537	Same as D521	
IC501	Integrated circuit, SN7400	DIC125001
IC502	Integrated circuit, SN7404	DIC125041
IC503	Integrated circuit, SN7410	DIC125101
IC504	Integrated circuit, SN7476	DIC125761
S500	Push Switch, KSD7-18-10MLDC	DSW013362
S510	Push Switch, KSD3-6-10ILDC	DSW013091
RA510	Resistor Array, RM-4-10KΩ	DFB015541
RA520	Same as RA510	
J560	Connector (IC Socket)	DSK045601
P510	Connector, 65532-X36	DCN033521
P550	Connector, U-PA1519	DCN031131
P560	Connector (Plug with Flat Cable)	KHB030711

CKT. NO.	DESCRIPTION	IWATSU PART NO.
VERTICAL MAIN AMPLIFIER		
C1302	Cap., 4p, ±0.5%, 50V, Cer.	DCC230801
C1318	Same as C1302	
C1321	Cap., 4 ~ 10p, Var., 50V, Cer.	DCV010221
C1323	Cap., 10p, ±0.5%, 50V, Cer.	DCC231701
C1326	Cap., 15p, ±5%, 50V, Cer.	DCC232001
C1327	Cap., 33p, ±5%, 50V, Cer.	DCC232801
C1335A	Cap., 470p, ±5%, 50V, Cer.	DCC235301
C1336	Cap., 0.22μ, ±10%, 50V, Plastic	DCF120391
C1337	Cap., 0.022μ, ±10%, 50V, Plastic	DCF120271
C1338	Cap., 1000p, ±10%, 50V, Plastic	DCF120111
C1339	Cap., 2.2μ, ±0.5%, 25V, Elect.	DCE925611
C1340	Cap., 22μ, ±0.5%, 6.3V, Elect.	DCE910081
C1341	Cap., 39p, ±5%, 50V, Cer.	DCC233001
C1342	Cap., 25p, Var., 500V, Cer.	DCV012161
C1359	Same as C1302	
C1360	Cap., 5p, Var., 50V, Cer.	DCV010211
C1371	Cap., 0.01μ, +80 −20%, 50V, Cer.	DCC133571
C1375	Same as C1375	
C1378	Same as C1323	
C1391	Cap., 0.01μ, +80 −20%, 50V, Cer.	DCC133571
C1393	Same as C1375	
C1394	Cap., 22μ, +100 −10%, 25V, Elect.	DCE122551
C1395	Same as C1375	
L1302	Inductor, Coil	DCL150572
L1360	Inductor, Coil 3t	DCL150442
L1390	Inductor, Coil	DCL150992
L1391	Same as L1390	
L1393	Same as L1360	
R1301	Res., 56, ±2%, 1/4W, Metal	DRE133431
R1302	Same as R1301	
R1303	Res., 30, ±1%, 1/8W, Metal	DRF520391
R1304	Same as R1303	
R1305	Res., 470, ±5%, 1/4W, Carbon	DRD130751
R1306	Same as R1305	
R1310	Res., 820, ±2%, 1/4W, Metal	DRE133711
R1311	Same as R1310	
R1312	Res., 500, ±20%, 0.5W, Cermet	DRV416221
R1313	Res., 20K, ±5%, 1/4W, Carbon	DRD131141
R1316	Res., 5.6K, ±5%, 1/4W, Carbon	DRD131011

CKT. NO.	DESCRIPTION	IWATSU PART NO.
R1317	Res., 10K, ±20%, Thermistor	DDD080431
R1318	Res., 51, ±5%, 1/4W, Compo.	DRC132441
R1321	Res., 200, ±20%, 0.5W, Cermet	DRV416201
R1323	Res., 51, ±5%, 1/4W, Compo.	DRC132441
R1324	Res., 330, ±2%, 1/4W, Metal	DRE133611
R1325	Res., 910, ±2%, 1/4W, Metal	DRE133721
R1326	Res., 430, ±5%, 1/4W, Carbon	DRD130741
R1327	Res., 910, ±5%, 1/4W, Carbon	DRD130821
R1330	Res., 8.2K, ±2%, 1/4W, Metal	DRE133951
R1331	Res., 1.1K, ±2%, 1/4W, Metal	DRE133741
R1332	Same as R1330	
R1333	Res., 2K, ±2%, 1/4W, Metal	DRE133801
R1334	Same as R1333	
R1335A	Same as R1313	
R1336	Res., 100, ±20%, 0.5W, Cermet	DRV416281
R1337	Same as R1336	
R1338	Same as R1336	
R1339	Res., 30K, ±5%, 1/4W, Carbon	DRD131181
R1340	Res., 27K, ±5%, 1/4W, Carbon	DRD131171
R1341	Res., 50, ±20%, 0.5W, Cermet	DRV416271
R1345	Res., 390, ±2%, 1/4W, Metal	DRE133631
R1346	Same as R1345	
R1347	Res., 300, ±5%, 1/4W, Carbon	DRD130701
R1348	Same as R1347	
R1350	Res., 300, ±2%, 1/4W, Metal	DRE133601
R1351	Same as R1350	
R1352	Res., 360, ±1%, 1/8W, Metal	DRE535341
R1353	Res., 5K, ±20%, 0.5W, Cermet	DRV416241
R1354	Res., 82, ±1%, 1/8W, Metal	DRE520461
R1355	Same as R1354	
R1356	Res., 33, ±5%, 1/4W, Compo.	DRC132391
R1357	Same as R1356	
R1358	Same as R1339	
R1359	Res., 390, ±5%, 1/4W, Carbon	DRD130731
R1360	Same as R1318	
R1361	Same as R1318	
R1362	Same as R1303	
R1363	Same as R1303	
R1364	Res., 100, ±5%, 1/4W, Compo.	DRC132511
R1365	Same as R1317	
R1366	Res., 200, ±1%, 1/8W, Metal	DRE520111
R1367	Res., 330, ±1%, 1/8W, Metal	DRE520531
R1368	Res., 100, ±20%, Thermistor	DDD080331

CKT. NO.	DESCRIPTION	IWATSU PART NO.	CKT. NO.	DESCRIPTION	IWATSU PART NO.
R1369	Res., 330, ±5%, 1/4W, Compo.	DRE132631	P1301	Connector, 65532X36	DCN033501
R1370	Res., 240, ±2%, 1W, Metal	DRE153581	P1391	Same as P1301	
R1371	Res., 750, ±5%, 1/4W, Carbon	DRD130801	P1395	Same as P1301	
R1372	Res., 620, ±2%, 1/4W, Metal	DRE133681			
R1373	Res., 470, ±2%, 1/4W, Metal	DRE133651			
R1374	Res., 51, ±1%, 1/8W, Metal	DRE520421			
R1375	Res., 47, ±2%, 1/4W, Metal	DRE133411			
R1376	Res., 75, ±1%, 1/8W, Metal	DRE520451			
R1377	Same as R1376				
R1378	Same as R1323				
R1380	Res., 11, ±5%, 1/4W, Compo.	DRC132281			
R1381	Same as R1380				
R1382	Res., 200, ±2%, 1/2W, Metal	DRE143561			
R1383	Res., 180, ±2%, 1/2W, Metal	DRE143551			
R1384	Same as R1383				
R1385	Same as R1382				
R1386	Res., 47, ±5%, 1/4W, Carbon	DRD130511			
R1390	Res., 157, ±2%, 4W, Metal	DIC830031			
D1314	V.C. Diode, 1S1922D	DDD990111			
D1315	V.C. Diode, 1S1924	DDD010391			
D1316	Diode, 1S953	DDD010051			
D1317	Same as D1314				
D1350	Z. Diode, RD5.1E	DDD030571			
D1351	Same as D1350				
D1360	Same as D1314				
D1361	Same as D1314				
Q1330	Transistor, 2SC373	DTR137781			
Q1332	Same as Q1330				
Q1340	Transistor, 2SC495	DTR116111			
Q1342	Same as Q1340				
Q1360	Transistor, FT1125	DTR190321			
Q1362	Same as Q1360				
Q1364	Same as Q1360				
Q1366	Same as Q1360				
IC1320	Integrated circuit, A-42	DIC810421			
IC1380	Integrated circuit, C2	DIC830021			
J1301	Connector, 65039-033 (4P)	DCN033111			
J1395	Connector, 65039-032 (5P)	DCN033101			

CKT. NO.	DESCRIPTION	IWATSU PART NO.
A TRIGGER GENERATOR		
C604	Cap., 5p, ±1% , 50V, Cer.	DCC231701
C624	Cap., 0.01μ, +80 −20%, 50V, Cer.	DCC139501
C626	Cap., 3.3μ, ±20%, 35V, Elect. Tan.	DCS471011
C627	Same as C626	
C631	Same as C624	
C633	Cap., 1μ, ±0.5%, 50V, Elect.	DCE940581
C636	Cap., 5p, +80 −20%, 50V, Cer.	DCC230901
C643	Cap., 4700p, ±10%, 50V, Plastic	DCF129081
C644	Same as C624	
C661	Same as C624	
C662	Same as C624	
C673	Same as C636	
C676	Cap., 10μ, ±20%, 35V, Elect. Tan	DCS479081
C678	Same as C604	
C691	Same as C676	
C692	Same as C624	
C693	Same as C676	
C694	Same as C624	
C695	Same as C676	
C696	Same as C624	
R601	Res., 680, ±2%, 1/4W, Metal	DRE133691
R602	Res., 68, ±1%, 1/8W, Metal	DRE520441
R603	Same as R601	
R604	Res., 15, ±5%, 1/4W, Compo.	DRC132311
R611	Res., 30, ±1%, 1/8W, Metal	DRE520391
R612	Res., 51, ±1%, 1/8W, Metal	DRE520421
R613	Same as R612	
R614	Same as R611	
R615	Res., 510, ±5%, 1/4W, Carbon	DRD139401
R616	Same as R615	
R621	Res., 1.5k, ±5%, 1/4W, Carbon	DRD139431
R622	Res., 30, ±5%, 1/4W, Carbon	DRD139081
R623	Res., 110, ±5%, 1/4W, Carbon	DRD139031
R624	Res., 56, ±5%, 1/4W, Carbon	DRD139271
R625	Res., 4.3k, ±5%, 1/4W, Carbon	DRD139951
R631	Res., 47, ±5%, 1/4W, Carbon	DRD130511
R632	Res., 10k, ±5%, 1/4W, Carbon	DRD139161
R633	Res., 2k, ±5%, 1/4W, Carbon	DRD130901
R635	Same as R611	
R636	Res., 51, ±5%, 1/4W, Compo.	DRC132441

CKT. NO'	DESCRIPTION	IWATSU PART NO.
R637	Res., 100, ±2%, 1/4W, Metal	DRE133491
R641	Res., 2k, Var., 0.5W, Cermet	DRV420181
R642	Res., 3k, ±5%, 1/4W, Carbon	DRD139491
R643	Res., 8.2k, ±5%, 1/4W, Carbon	DRD139581
R644	Same as R632	
R645	Res., 20k, ±2%, 1/4W, Metal	DRE134041
R646	Res., 10k, ±2%, 1/4W, Metal	DRE939301
R647	Res., 300, ±5%, 1/4W, Carbon	DRD139341
R651	Same as R611	
R652	Res., 300, ±2%, 1/4W, Metal	DRE133601
R655	Res., 2.2k, ±2%, 1/4W, Metal	DRE939021
R657	Res., 20k, Var., 0.125W, Carbon	DRV146011
R664	Same as R632	
R665	Res., 6.2k, ±5%, 1/4W, Carbon	DRD139551
R666	Res., 10k, Var., 0.5W, Cermet	DRV411081
R671	Res., 750, ±5%, 1/4W, Carbon	DRD139401
R672	Same as R615	
R673	Same as R636	
R674	Res., 30, ±5%, 1/4W, Compo.	DRC132381
R675	Same as R674	
R676	Res., 43, ±5%, 1/4W, Carbon	DRD130501
R678	Res., 10, ±5%, 1/4W, Compo.	DRC132271
R692	Res., 10, ±5%, 1/4W, Carbon	DRD139211
R694	Res., 3.3, ±5%, 1/4W, Compo.	DRC132151
R696	Same as R692	
D634	Diode, 1S953	DDD010821
D663	Same as D634	
D664	Same as D634	
D674	Diode, 1SS16	DDD010411
D675	Same as D674	
D676	Z. Diode, RD6-2E	DDD032171
Q601	Transistor, 2SC1424	DTR136931
Q603	Same as Q601	
Q604	Same as Q601	
Q605	Transistor, 2SC1254	DTR130861
Q631	Same as Q605	
IC645	Integrated circuit, μPC251C	DIC610091
IC651	Integrated circuit, A46	DIC810461
IC665	Integrated circuit, SN7400N	DIC125001

CKT. NO.	DESCRIPTION	IWATSU PART NO.
S643abc	Push Switch, KSD3-6-20 MLDC	DCW013351
J601	Connector, 65039-031	DCN033091
J611	Connector, 65039-033	DCN034621
J651	Connector, 65039-032	DCN033101
P601	Connector, 65532-X36	DCN033521
P611	Same as P601	
P651	Same as P601	
P652	Same as P601	

B TRIGGER GENERATOR

CKT. NO.	DESCRIPTION	IWATSU PART NO.
C901	Cap., 0.047μ, ±20%, 600V, Plastic	DCF171131
C902	Cap., 1000p, ±10%, 500V, Cer.	DCC151811
C904	Cap., 0.01μ, +80 −20%, 50V, Cer.	DCC139501
C906	Same as C904	
C907	Cap., 5p, ±0.25%, 50V, Cer.	DCC230901
C911	Same as C904	
C912	Cap., 75p, ±5%, 50V, Cer.	DCC233701
C918	Same as C904	
C931	Same as C904	
C935	Cap., 22μ, +100 −10%, 16V, Elect.	DCE220551
C941	Same as C907	
C944	Cap., 10μ, ±20%, 35V, Elect. Tan.	DCS479081
C946	Same as C904	
C947a	Same as C944	
C947b	Same as C904	
C948a	Same as C944	
C948b	Same as C904	
C949a	Same as C944	
C949b	Same as C904	
R901	Res., 51, ±5%, 1/4W, Compo.	DRC132441
R902	Res., 560k, ±5%, 1/4W, Compo.	DRC133411
R903	Res., 1M, ±0.5%, 1/2W, Metal	DRE244101
R904	Res., 5.1k, ±5%, 1/4W, Carbon	DRD131001
R905	Res., 2k, ±5%, 1/4W, Carbon	DRD139451
R906	Same as R904	
R907	Same as R901	
R908	Res., 750, ±5%, 1/4W, Carbon	DRD139401
R909	Res., 510, ±5%, 1/4W, Carbon	DRD139381
R911	Res., 100, ±5%, 1/4W, Carbon	DRD139291
R912	Res., 200, ±5%, 1/4W, Carbon	DRD139311
R913	Res., 82, ±5%, 1/4W, Carbon	DRD139981
R914	Res., 500, Var., 0.5W, Cermet	DRV411041
R915	Res., 5.1k, ±2%, 1/4W, Metal	DRE133901
R916	Res., 10k, Var., 0.5W, Cermet	DRV420201
R917	Res., 3.9k, ±2%, 1/4W, Metal	DRE939421
R918	Res., 20k, Var., 0.125W, Var. Cer.	DRV146011
R921	Same as R909	
R922	Res., 10k, ±2%, 1/4W, Metal	DRE939301
R923	Res., 20k, ±2%, 1/4W, Metal	DRE134041
R924	Res., 8.2k, ±5%, 1/4W, Carbon	DRD139581

CKT. NO.	DESCRIPTION	IWATSU PART NO.
R925	Res., 2k, Var., 0.5W, Cermet.	DRV420181
R926	Res., 3k, ±5%, 1/4W, Carbon	DRD139491
R927	Res., 4.3k, ±5%, 1/4W, Carbon	DRD139951
R928	Res., 390, ±5%, 1/4W, Compo.	DRC132651
R931	Res., 47, ±5%, 1/4W, Carbon	DRD139261
R932	Res., 10k, ±5%, 1/4W, Carbon	DRD139161
R933	Same as R905	
R935	Res., 1k, ±5%, 1/4W, Carbon	DRD139141
R936	Res., 100k, ±5%, 1/4W, Carbon	DRD139751
R937	Res., 30, ±5%, 1/4W, Compo.	DRC132381
R938	Same as R937	
R939	Res., 510, ±2%, 1W, Metal	DRE939131
R940	Res., 27, ±5%, 1/4W, Compo.	DRC132371
R941	Same as R901	
R942	Same as R937	
R943	Same as R937	
R944	Res., 43, ±5%, 1/4W, Carbon	DRD130501
R946	Same as R932	
R947	Res., 10, ±5%, 1/4W, Carbon	DRD139211
R948	Same as R947	
R949	Same as R947	
D904	Diode, 1S953	DDD010051
D906	Same as D904	
D934	Same as D904	
D944	Z. Diode, RD6.2E	DDD030611
D945	Same as D904	
D946	Same as D904	
D947	Same as D904	
Q911	FET, ITS30088C	DTR215321
Q912	Same as Q911	
Q931	Transistor, 2SC1254	DTR130861
IC941	Integrated circuit, A46	DIC810461
S901	Push Switch, KSD3-6-10LLDC	DSW013341
J901	BNC Connector, BNC-BR-226	DCN040111
J903	Connector, 65039-030	DCN033081
P902	Connector 65532-X36	DCN034941
P903	Same as P902	

CKT. NO.	DESCRIPTION	IWATSU PART NO.
A SWEEP GENERATOR		
C700	Cap., 0.01μ, +80 −20%, 50V, Cer.	DCC139501
C701	Same as C700	
C702	Cap., 10μ, +100 −10%, 35V, Elect.	DCE230501
C703	Same as C700	
C704	Same as C702	
C711	Cap., 1000p, +80, −20%, 50V, Cer.	DCC139051
C726	Same as C700	
C728	Cap., 3p, ±5%, 50V, Cer.	
C729	Cap., 10μ, ±20%, 35V, Elect. Tan.	
C732	Cap., 6p, ±0.5%, 50V, Cer.	DC231001
C741	Same as C729	
C742	Same as C700	
C743	Same as C732	
C755	Cap., 0.022μ, ±10%, 50V, Plastic	DCF129041
C762	Cap., 24p, ±10%, 50V, Cer.	DCC232501
C763	Same as C755	
C765	Same as C729	
C774	Cap., 39p, ±10%, 50V, Cer.	DCC239131
C775	Same as C700	
C776	Same as C729	
C791	Same as C729	
C793	Same as C700	
C806	Same as C700	
C807	Same as C700	
C809	Same as C700	
C812	Cap., 7p, ±10%, 50V, Cer.	DCC239101
C813	Same as C711	
C814	Cap., 270p, ±10%, 50V, Cer.	DCC234701
C816	Same as C711	
C835	Cap., 470p, ±10%, 50V, Cer.	DCC239151
C844	Cap., 15p, ±10%, 50V, Cer.	DCC232001
C856	Cap., 220p, ±10%, 50V, Cer.	DCC239171
C861	Cap., 2200p, ±10%, 50V, Plastic	DCF129061
C872	Same as C774	
C880	Same as C700	
C881	Cap., 4.7μ, +100 −10%, 35V, Elect.	DCE130411
C893	Cap., 82p, ±10%, 50V, Cer.	DCC233801
L700	Inductor, Coil 3t	DCL150442
L702	Same as L700	
L704	Same as L700	

CKT. NO.	DESCRIPTION	IWATSU PART NO.	CKT. NO.	DESCRIPTION	IWATSU PART NO.
L706	Same as L700		R764	Res., 7.5k, ±5%, 1/4W, Carbon	DRD139571
L731	Inductor, Coil 8ϕ 3t	DCL150552	R765	Same as R745	
			R766	Same as R712	
R711	Res., 51, ±1%, 1/4W, Metal	DRE535181	R767	Res., 910, ±2%, 1/4W, Metal	DRE939281
R712	Res., 20, ±5%, 1/4W, Carbon	DRD139061	R768	Res., 300, ±2%, 1/4W, Metal	DRE133601
R713	Same as R711		R770	Res., 47, ±1%, 1/4W, Metal	DRE535171
R714	Res., 120, ±1%, 1/4W, Metal	DRE535271	R771	Res., 2.7k, ±2%, 1/4W, Metal	DRE133831
R715	Same as R712		R772	Res., 9.1k, ±2%, 1/4W, Metal	742215400
R716	Res., 47, ±5%, 1/4W, Carbon	DRD139261	R773	Res., 330, ±2%, 1/4W, Metal	DRE133611
R721	Res., 10k, ±20%, 0.5W, Cermet	DRV411081	R774	Same as R771	
R722	Res., 3k, ±2%, 1/4W, Metal	DRD939031	R775	Res., 4.3k, ±5%, 1/4W, Carbon	DRD139951
R723	Res., 6.2k, ±2%, 1/4W, Metal	DRE133921	R777	Same as R723	
R724	Same as R716		R778	Res., 5.6k, ±2%, 1/4W, Metal	DRE133911
R726	Res., 750, ±2%, 1/4W, Metal	DRE939131	R779	Res., 510, ±2%, 1/4W, Metal	742213810
R728	Res., 1.8k, ±1%, 1/4W, Metal	DRE535551	R782	Res., 750, ±5%, 1/4W, Carbon	DRD139401
R728a	Res., 100, ±5%, 1/4W, Compo.	DRC132511	R783	Same as R716	
R729	Same as R726		R784	Res., 10k, ±5%, 1/4W, Carbon	DRD139161
R731	Res., 30, ±1%, 1/4W, Metal	DRE535131	R785	Res., 2k, ±5%, 1/4W, Carbon	DRD139451
R732	Res., 82, ±1%, 1/4W, Metal	DRE535231	R786	Res., 910, ±5%, 1/4W, Carbon	DRD139411
R733	Same as R721		R787	Res., 4.7k, ±1%, 1/4W, Metal	DRE535651
R734	Res., 4.7k, ±2%, 1/4W, Metal	DRE133891	R788	Res., 1.1k, ±2%, 1/4W, Metal	DRE133741
R735	Res., 1.2k, ±2%, 1/4W, Metal	DRE939291	R791	Res., 1.8k, ±2%, 1/4W, Metal	DRE939171
R736	Same as R711		R793	Res., 100, ±1%, 1/4W, Metal	DRE535251
R737	Res., 1k, ±5%, 1/4W, Carbon	DRD139141	R794	Same as R764	
R738	Res., 680, ±2%, 1/4W, Metal	DRE133691	R795	Same as R712	
R740	Res., 12k, ±5%, 1/4W, Carbon	DRE131091	R800	Res., 3k, ±1%, 1/4W, Metal	DRE535601
R741	Same as R721		R801	Res., 5.1k, ±2%, 1/2W, Metal	DRE143901
R742	Same as R734		R802	Res., 300, ±1%, 1/4W, Metal	DRE535361
R743	Same as R732		R803	Res., 1k, ±2%, 1/4W, Metal	DRE939071
R744	Same as R737		R804	Res., 5.1k, ±2%, 1/4W, Metal	DRE133901
R745	Res., 1.3k, ±2%, 1/4W, Metal	DRE133761	R805	Res., 3.3k, ±2%, 1/4W,Metal	DRE133851
R748	Same as R738		R807	Res., 3.6k, ±2%, 1/4W, Metal	DRE133861
R749	Res., 12k, ±1%, 1/4W, Metal	DRE535751	R808	Res., 560, ±5%, 1/4W, Carbon	DRD139121
R751	Res., 510, ±5%, 1/4W, Carbon	DRD139381	R809	Same as R761	
R752	Res., 82, ±5%, 1/4W, Carbon	DRD139981	R810	Res., 620, ±1%, 1/4W, Metal	DRE535441
R753	Res., 1.5k, ±2%, 1/4W, Metal	DRE133771	R811	Res., 2.2k, ±2%, 1/4W, Metal	DRE939021
R754	Res., 3.9k, ±5%, 1/4W, Carbon	DRD139521	R812	Same as R745	
R755	Res., 750, ±2%, 1/4W, Metal	DRE133701	R813	Res., 470, ±5%, 1/4W, Carbon	DRD139371
R756	Res., 2.4k, ±2%, 1/4W, Metal	DRE133821	R815	Same as R779	
R757	Res., 3.9k, ±2%, 1/4W, Metal	DRD939421	R816	Res., 120, ±5%, 1/4W, Carbon	DRD130611
R761	Res., 100, ±5%, 1/4W, Carbon	DRD130591	R817	Same as R716	
R762	Same as R737		R821	Res., 5k,±20%, 0.5W, Cermet	DRV411071
R763	Res., 130, ±5%, 1/4W, Carbon	DRD139331	R822	Res., 2.4k, 1%, 1/4W, Metal	DRE535581

CKT. NO.	DESCRIPTION	IWATSU PART NO.
R823	Res., 270, ±5%, 1/4W, Carbon	DRD139331
R824	Same as R771	
R826	Same as R802	
R827	Res., 2.4k, ±2%, 1/2W, Metal	DRE143821
R832	Same as R784	
R833	Same as R784	
R834	Res., 15k, ±5%, 1/4W, Carbon	DRD139611
R836	Res., 430, ±5%, 1/4W, Carbon	DRD130741
R837	Res., (100k +20k), Var., 0.125W, Carbon	DRV146281
R841	Same as R737	
R842	Res., 5.1k, ±5%, 1/4W, Carbon	DRD139531
R843	Same as R785	
R845	Same as R771	
R851	Same as R722	
R852	Res., 4.3k, ±2%, 1/4W, Metal	DRE143881
R853	Same as R738	
R854	Res., 560, ±2%, 1/4W, Metal	742215690
R855	Same as R788	
R856	Res., 1.3k, ±5%, 1/4W, Carbon	DRD138751
R857	Res., 9.1k, ±5%, 1/4W, Carbon	DRD139591
R861	Same as R754	
R863	Same as R784	
R864	Same as R784	
R865	Res., 2.2k, ±5%, 1/4W, Carbon	DRD139461
R871	Res., 2.2k, ±1%, 1/4W, Metal	DRE535571
R872	Res., 1.5k, ±5%, 1/4W, Carbon	DRD139431
R873	Res., 2.7k, ±5%, 1/4W, Carbon	DRD139481
R874	Same as R842	
R875	Same as R836	
R876	Same as R873	
R877	Res., 1.1k, ±5%, 1/4W, Carbon	DRD130841
R881	Res., 30k, ±5%, 1/4W, Carbon	DRD139671
R883	Res., 300, ±5%, 1/4W, Carbon	DRD139341
R884	Same as R800	
R885	Same as R865	
R886	Res., 3k, ±5%, 1/4W, Carbon	DRD130941
R887	Res., 240, ±1%, 1/4W, Metal	DRE535341
R888	Res., 1.2k, ±5%, 1/4W, Carbon	DRD139421
R891	Same as R737	
R892	Res., 6.2k, ±5%, 1/4W, Carbon	DRD135021
R894	Res., 390, ±5%, 1/4W, Carbon	DRD139261
D727	Diode, 1SS16	740405180

CKT. NO.	DESCRIPTION	IWATSU PART NO.
D728	Same as D727	
D731	T. Diode, 1S2200	DDD050201
D736	Same as D731	
D737	Diode, 1S953	DDD010051
D738	Same as D727	
D739	Same as D737	
D740	Same as D737	
D745	Same as D731	
D746	Same as D727	
D747	Same as D737	
D748	Same as D727	
D749	Same as D727	
D749a	Same as D737	
D750	Same as D737	
D751	Same as D737	
D754	Same as D737	
D755	Z. Diode, RD3.9E	DDD032921
D756	Same as D727	
D757	Same as D727	
D761	Same as D737	
D781	Same as D737	
D782	Same as D737	
D791	Same as D737	
D792	Same as D737	
D801	Z. Diode, RD 9.1E	DDD030591
D806	Z. Diode, RD20EB	DDD034091
D807	Same as D755	
D824	Same as D737	
D825	Same as D737	
D831	Same as D737	
D832	Same as D737	
D836	Same as D737	
D841	Same as D737	
D843	Same as D737	
D844	Same as D737	
D845	Same as D737	
D851	Same as D737	
D853	Same as D737	
D855	Same as D737	
D856	Same as D737	
D857	Same as D737	
D865	Same as D737	
D866	Same as D737	

CKT. NO.	DESCRIPTION	IWATSU PART NO.
D871	Same as D737	
D874	Same as D737	
D876	Same as D727	
D881	Same as D737	
D883	Same as D737	
D884	Same as D737	
D885	Same as D737	
D886	Same as D737	
D888	Same as D737	
D889	Same as D737	
D892	Same as D737	
Q712	Transistor, FT1125	DTR190321
Q715	Same as Q712	
Q754	Transistor, 2SC1216	740306170
Q761	Transistor, 2SC373	DTR137781
Q764	Transistor, 2N3905	DTR150011
Q766	Same as Q764	
Q768	Same as Q754	
Q772	Same as Q754	
Q775	Same as Q754	
Q778	Same as Q754	
Q785	Same as Q761	
Q788	Same as Q761	
Q792	Transistor, 2SC1254	DTR130861
Q793	Same as Q754	
Q795	Transistor, 2SA578	DTR110331
Q801	FET, ITS-30088C	DTR215321
Q802	Same as Q754	
Q804	Same as Q754	
Q808	Same as Q754	
Q824	Same as Q754	
Q825	Same as Q754	
Q833	Transistor, 2SA495	DTR116111
Q841	Same as Q764	
Q851	Same as Q764	
Q853	Same as Q764	
Q857	Transistor, 2SC1424	DTR136931
Q863	Same as Q764	
Q865	Same as Q754	
Q871	Same as Q754	
Q885	Same as Q754	
Q891	Same as Q754	

CKT. NO.	DESCRIPTION	IWATSU PART NO.
IC881	Integrated circuit, SN74122N	DIC126161
IC883	Integrated circuit, SN7403N	DIC125031
RA883	Resistor Array, RM4 2.7kΩ	DFB015531
PJ711	Connector, 129-08-10-281	DCN032371
TP730	Test Point Terminal	KPS005521
TP740	Same as TP730	
J550	Connector, U-SA1501	DCN031171
J652	Connector, 65039-033 (4P)	DCN034621
J702	Connector, 65039-035 (2P)	DCN033131
J783	BNC Connector, BNC-BR-226	DCN040711
P702	Connector, 65532-X36 (2PX1)	DCN033521

CKT. NO.	DESCRIPTION	IWATSU PART NO.	CKT. NO.	DESCRIPTION	IWATSU PART NO.
B SWEEP GENERATOR			R950	Res., 100, ±5%, 1/4W, Carbon	DRD139291
			R951	Res., 2k, ±5%, 2W, W.W.	DRV770271
C951	Cap., 0.01μ, +80 −20%, 50V, Cer.	DCC139501	R952	Res., 910, ±2%, 1/4W, Metal	
C952	Cap., 10μ, ±20%, 35V, Elect. Tan.	DCS471301	R953	Res., 500, ±20%, 1/2W, Cermet	DRV411041
C954	Same as C951		R955	Same as R953	
C955	Same as C952		R957	Res., 200, ±5%, 1/4W, Carbon	DRD139311
C957	Same as C951		R958	Res., 3k, ±5%, 1/4W, Carbon	DRD139491
C958	Same as C952		R959	Res., 620, ±5%, 1/4W, Carbon	DRD139131
C972	Cap., 0.047μ, ±10%, 50V, Plastic	DCF129111	R962	Same as R959	
C977	Cap., 12p, ±10%, 50V, Cer.	DCC231901	R964	Same as R957	
C983	Cap., 22p, ±10%, 50V, Cer.	DCC239121	R965	Res., 3k, ±2%, 1/4W, Metal	DRE133841
C993	Same as C951		R966	Res., 1.1k, ±2%, 1/4W, Metal	DRE133741
C996	Cap., 39p, ±10%, 50V, Cer.	DCC233001	R967	Res., 5.1k, ±2%, 1/4W, Metal	DRE133901
C1001a	Same as C952		R968	Same as R950	
C1001b	Same as C951		R970a	Res., 16k, ±5%, 1/4W, Carbon	DRD135121
C1002a	Same as C1001a		R970b	Res., 39k, ±5%, 1/4W, Carbon	DRD139701
C1002b	Same as C951		R971	Res., 8.2k, ±5%, 1/4W, Carbon	DRD139581
C1004	Same as C951		R972	Res., 1.5k, ±5%, 1/4W, Carbon	DRD139431
C1005	Same as C951		R973	Same as R972	
C1006	Same as C951		R974	Res., 5.1k, ±2%, 1/2W, Metal	DRE143901
C1007	Same as C952		R975	Res., 20k, ±2%, 1/4W, Metal	DRE134041
C1008	Same as C951		R976	Res., 430, ±2%, 1/4W, Metal	DRE133641
C1009	Same as C952		R977	Res., 9.1k, ±2%, 1/4W, Metal	DRE939081
C1013	Cap., 1000p, +80 −20%, 50V, Cer.	DCC139051	R978	Res., 3.3k, ±5%, 1/4W, Carbon	DRD139501
C1029	Cap., 10p, ±10%, 50V, Cer.	DCC232901	R979	Same as R978	
C1033	Cap., 0.1μ, ±10%, 50V, Plastic	DCF120351	R980	Res., 10k, ±1%, 1/4W, Metal	DRE535731
C1047	Cap., 100p, ±10%, 50V, Cer.	DCC239151	R981	Res., 5.1k, ±5%, 1/4W, Carbon	DRD139531
C1052	Same as C951		R982	Res., 1k, ±5%, 1/4W, Carbon	DRD139141
C1054	Same as C952		R983	Res., 1.2k, ±5%, 1/4W, Carbon	DRD130851
C1071	Same as C952		R984	Res., 2.4k, ±1%, 1/4W, Metal	DRE535581
C1072	Same as C1013		R987	Res., 3.6k, ±5%, 1/4W, Carbon	DRD130961
C1084	Same as C951		R991	Res., 2.7k, ±2%, 1/4W, Metal	DRE133821
C1092	Same as C977		R992	Res., 3.6k, ±2%, 1/4W, Metal	DRE133851
C1093	Same as C1013		R993	Res., 20, ±5%, 1/4W, Carbon	DRD139061
C1094	Same as C1013		R994	Res., 620, ±2%, 1/4W, Metal	DRE133681
C1095	Cap., 220p, ±10%, 50V, Cer.	DCC234501	R995	Same as R994	
C1096	Same as C951		R996	Res., 2k, ±2%, 1/4W, Metal	DRE939011
			R997	Same as R965	
L1001	Inductor, Coil 3t	DCL150442	R998	Same as R957	
L1002	Same as L1001		R1000	Res., 30, ±5%, 1/4W, Carbon	DRD130461
L1007	Same as L1001		R1001	Res., 5.1k, ±2%, 1/2W, Metal	DRE143901
L1009	Same as L1001		R1002	Same as R958	
L1028	Inductor, Coil 8φ 3t	DCL150552	R1003	Res., 560, ±5%, 1/4W, Carbon	DRD139121

CKT. NO.	DESCRIPTION	IWATSU PART NO.	CKT. NO.	DESCRIPTION	IWATSU PART NO.
R1004	Same as R992		R1082	Res., 2k, ±20%, 1/2W, Cermet	DRV411061
R1011	Same as R993		R1083	Same as R1056	
R1012	Res., 51, ±1%, 1/4W, Metal	DRE535181	R1084	Res., 13k, ±2%, 1/4W, Metal	DRE134001
R1013	Res., 120, ±1%, 1/4W, Metal	DRE535271	R1085	Same as R993	
R1014	Same as R1012		R1086	Res., 300, ±5%, 1/4W, Carbon	DRD139341
R1015	Same as R993		R1087	Res., 3.3k, ±2%, 1/4W, Metal	742214470
R1016	Res., 47, ±5%, 1/4W, Carbon	DRD139261	R1088	Same as R982	
R1017	Res., 20, ±1%, 1/4W, Metal	DRE535081	R1089	Same as R981	
R1018	Same as R994		R1091	Same as R1081	
R1019	Same as R994		R1092	Same as R1036	
R1024	Res., 10k, ±20%, 1/2W, Cermet	DRV411081	R1093	Res., 470, ±5%, 1/4W, Carbon	DRD130751
R1025	Same as R1016		R1094	Res., 120, ±5%, 1/4W, Carbon	DRD139301
R1026	Same as R965		R1095	Res., 510, ±2%, 1/4W, Metal	DRE133661
R1027	Res., 6.2k, ±2%, 1/4W, Metal	DRE939021	R1096	Same as R1016	
R1028	Res., 36, ±5%, 1/4W, Carbon	DRD139291	R1097	Same as R991	
R1029	Res., 43, ±5%, 1/4W, Carbon	DRD138841	R1098	Same as R1086	
R1031	Res., 6.2k, ±5%, 1/4W, Carbon	DRD139601	R1099	Res., 2.4k, ±2%, 1/2W, Metal	DRE133941
R1032	Same as R959				
R1033	Res., 1.6k, ±5%, 1/4W, Carbon	DRD139501	D978	Diode, 1S953	DDD010051
R1034	Same as R1024		D979	Same as D978	
R1035	Same as R967		D983	Same as D978	
R1036	Res., 1.3k, ±2%, 1/4W, Metal	DRE133831	D984	Diode, 1SS16	DDD010411
R1040	Res., 12k, ±1%, 1/4W, Metal	DRE535751	D985	Same as D978	
R1043	Res., 680, ±2%, 1/4W, Metal	DRE133771	D986	Same as D978	
R1044	Same as R958		D987	Same as D984	
R1045	Same as R971		D988	Same as D978	
R1046	Same as R993		D998	Same as D978	
R1047	Res., 150, ±5%, 1/4W, Carbon	DRD139101	D1001	Z. Diode, RD9.1E	DDD030591
R1051	Same as R1000		D1004	Z. Diode, RD4.3EB	DDD034831
R1053	Res., 300, ±2%, 1/4W, Metal	DRE133601	D1005	Z. Diode, RD20EB	DDD034091
R1054	Res., 1k, ±2%, 1/4W, Metal	DRE939071	D1026	T. Diode, 1S2200	DDD050121
R1055	Res., 100, ±2%, 1/4W, Metal	DRE133491	D1031	Same as D978	
R1056	Res., 5.6k, ±2%, 1/4W, Metal	DRE133911	D1041	Same as D1026	
R1061	Same as R965		D1042	Same as D978	
R1062	Same as R967		D1043	Same as D984	
R1063	Res., 820, ±5%, 1/4W, Carbon	DRD139941	D1044	Same as D984	
R1065	Res., 750, ±5%, 1/4W, Carbon	DRD139401	D1045	Same as D978	
R1066	Same as R1016		D1046	Same as D978	
R1067	Res., 9.1k, ±5%, 1/4W, Carbon	DRD131061	D1064	Same as D978	
R1068	Same as R958		D1065	Same as D978	
R1071	Res., 910, ±2%, 1/4W, Metal	DRE939281	D1071	Same as D978	
R1072	Same as R1036		D1072	Same as D978	
R1081	Res., 2.2k, ±2%, 1/4W, Metal	DRE939031	D1073	Same as D978	

CKT. NO.	DESCRIPTION	IWATSU PARTS NO.
D1075	Same as D978	
D1082	Same as D978	
D1096	Same as D978	
D1097	Same as D978	
Q970	Transistor, 2SC373	DTR137781
Q976	Transistor, 2N3905	DTR150011
Q977	Same as Q976	
Q983	Same as Q976	
Q988	Transistor, 2SC1216	DTR130791
Q992	Same as Q976	
Q995	Same as Q995	
Q1003	Same as Q970	
Q1005	Same as Q988	
Q1011	Same as Q988	
Q1015	Same as Q988	
Q1045	Same as Q988	
Q1051	Same as Q988	
Q1055	Same as Q988	
Q1061	Same as Q970	
Q1064	Same as Q970	
Q1075	Transistor, 2SC1254	DTR130861
Q1085	Transistor, 2SA578	DTR110331
Q1086	FET, ITS30088C	DTR215321
Q1087	Same as Q988	
Q1096	Same as Q988	
Q1097	Same as Q988	
IC961	Integrated circuit, μPC251C	DIC610091
IC966	Integrated circuit, CA3086	DTR190381
PJ722	Connector, 129-08-10-281	DCN032371
J708	Connector, 65039-035	DCN033131
J721	Connector, 65039-034 (3P)	DCN033121
J902	Connector, 65039-031 (tP)	DCN034641
J1066	BNC Connector, BNC-BR-226	DCN040711
P708	Connector, 65532-X36 (2P x 1)	DCN033521
P721	Connector, 65532-X36 (3P x 1)	DCN033521

CKT. NO.	DESCRIPTION	IWATSU PARTS NO.
A & B TIMING SWITCHES		
C1111	Cap., 3.3μ, ±20%, 35V, Elect. Tan.	DCS471011
C1112	Cap., 0.47μ,±20%, 35V, Elect. Tan.	DCS470501
C1113	Cap., 0.033μ, ±10%, 50V, Plastic	DCF120291
C1114	Cap., 4700p, ±10%, 50V, Plastic	DCF120191
C1115	Same as C114	
C1181	Cap., 0.1μ, ±0.25%, 50V, Plastic	DCF420271
C1182	Cap., 9900p, ±0.25%, 50V, Plastic	DCF125791
C1183	Cap., 890p, ±0.25%, 50V, Plastic	DCF125811
C1184	Cap., 25p, Var., 500V, Cer.	DCV012551
C1185	Same as C1184	
C1187	Cap., 1μ, ±0.25%, 50V, Plastic	DCF420281
C1188	Cap., 68p, ±5%, 100V, Mica	DCM243031
C1191	Same as C1187	
C1192	Same as C1181	
C1193	Same as C1182	
C1194	Cap., 880p, ±0.25%, 50V, Plastic	DCF125851
C1195	Same as C1184	
C1196	Same as C1184	
C1199	Same as C1188	
R1104	Res., 2.7k, ±5%, 1/4W, Carbon	DRD139481
R1120	Res., 3.6M, ±1%, 1/2W, Metal	DRE540401
R1121	Res., 3.9M, ±1%, 1/2W, Metal	DRE540411
R1122	Res., 2.49M, ±1%, 1/2W, Metal	DRE540361
R1123	Res., 1.24M, ±1%, 1/2W, Metal	DRE540371
R1124	Res., 750k, ±0.5%, 1/2W, Metal	DRE243851
R1125	Res., 250k, ±0.5%, 1/2W, Metal	DRE243611
R1126	Same as R1125	
R1127	Res., 18k, ±1%, 1/4W, Metal	DRE535791
R1128	Res., 33k, ±1%, 1/4W, Metal	DRE532361
R1131	Res., 125k, ±0.5%, 1/2W, Metal	DRE243531
R1132	Res., 50k, ±0.5%, 1/2W, Metal	DRE243411
R1133	Res., 25k, ±0.5%, 1/2W, Metal	DRE243331
R1134	Res., 13k, ±2%, 1/4W, Metal	DRE134001
R1135	Res., 5k, ±20%, 0.5W, Cermet	DRV416241
R1136	Res., 5.1k, ±2%, 1/4W, Metal	DRE133901
R1137	Res., 2k, ±20%, 0.5W, Cermet	DRV416231
R1138	Res., 2.4k, ±2%, 1/4W, Metal	DRE133821
R1139	Res., 1k, ±20%, 0.5W, Cermet	DRV416191
R1141	Res., 6.2k, ±5%, 1/4W, Carbon	DRD139551
R1142	Same as R1141	

CKT. NO.	DESCRIPTION	IWATSU PARTS NO.
R1143	Res., 3k, ±5%, 1/4W, Carbon	DRD139491
R1144	Res., 200, ±5%, 1/4W, Carbon	DRD139311
R1151	Res., 1k, ±5%, 1/4W, Carbon	DRD139141
R1152	Res., 3.3k, ±2%, 1/4W, Metal	DRE939421
R1153	Same as R1137	
R1154	Res., 20k, Var., 0.125W, Carbon, with Switch	DRV146091
R1155	Res., 1.1k, ±2%, 1/4W, Metal	DRE939771
R1156	Same as R1144	
R1157	Res., 3.9k, ±2%, 1/4W, Metal	DRE133871
R1161	Res., 15k, ±5%, 1/4W, Carbon	DRD13961
R1162	Same as R1161	
R1164	Same as R1124	
R1165	Same as R1125	
R1166	Same as R1125	
R1171	Same as R1131	
R1172	Same as R1132	
R1173	Same as R1133	
R1174	Same as R1135	
R1175	Same as R1134	
R1176	Same as R1137	
R1177	Same as R1136	
R1178	Same as R1139	
R1179	Same as R1138	
D1102	Diode, 1S953	DDD010051
D1104	Same as D1102	
D1140	Same as D1102	
D1141	Same as D1140	
D1144	Same as D1140	
D1151	L.E. Diode, TLR104	DDD070291
D1185	Same as D1140	
D1186	Same as D1140	
D1197	Same as D1140	
D1198	Same as D1140	
Q1143	Transistor, 2SC373	DTR137781
Q1181	Transistor, 2SC1216	DTR130791
Q1182	Same as Q1181	
Q1183	Same as Q1181	
Q1184	Same as Q1181	
Q1185	Same as Q1181	
Q1186	Same as Q1143	
Q1191	Same as Q1181	
Q1192	Same as Q1181	
Q1193	Same as Q1181	
Q1194	Same as Q1181	
Q1195	Same as Q1181	
Q1196	Same as Q1181	
Q1197	Same as Q1143	
IC1104	Integrated circuit, SN7405N	DIC125051
IC1105	Same as IC1104	
IC1141	Integrated circuit, SN7402N	DIC125021
RL1186	Reed Relay, RE0113	DKD065841
RL1187	Same as RL1186	
RL1197	Same as RL1186	
S1100a.b	Rotary Switch, PS43G (24)2-3-21/RV	DSW034472
DA1101	Diode Array, DAP4	DDD010311
DA1103	Same as DA1101	
RA1101	Resistor Array, RM8 10kΩK	DFB015631
RA1103	Same as RA1101	
RA1104	Resistor Array, RM4 2.7kΩK	DFB016071
RA1105	Resistor Array, RM6 2.7kΩK	DFB016231
PJ1033	Connector, 128-08-10-281	DCN032341
J701	Connector, 65039-035	DCN033131
J705	Same as J701	
J707	Same as J701	
P701	Connector, 65532-X36	DCN033521
P705	Same as P701	
P707	Same as P701	

HORIZONTAL CONTROL

CKT. NO.	DESCRIPTION	IWATSU PARTS NO.
C1225	Cap., 4.7μ, +100 −10%, 35V, Elect.	DCE130411
R1212	Res., 1k, ±5%, 1/4W, Carbon	DRD139141
R1215	Res., 3k, ±5%, 1/4W, Carbon	DRD139491
R1216	Same as R1215	
R1232	Same as R1215	
R1235	Same as R1212	
R1262	Res., 5.1k, ±2%, 1/4W, Metal	DRE133901
R1264	Same as R1262	
R1265	Res., 7.5k, ±5%, 1/4W, Carbon	DRD139571
R1266	Res., 750, ±5%, 1/4W, Carbon	DRD130801
R1267	Same as R1266	
R1268	Same as R1265	
R1269	Same as R1212	
R1272	Res., 12k, ±5%, 1/4W, Carbon	DRD131091
R1273	Res., 10k, ±5%, 1/4W, Carbon	DRD139196
R1275	Res., 30k, ±5%, 1/4W, Carbon	DRD139671
R1276	Same as R1275	
R1281	Res., 5.1k, ±5%, 1/4W, Carbon	DRD139531
R1292	Same as R1281	
D1211	L.E. Diode, TLR104	DDD070291
D1212	Diode, 1S953	DDD010821
D1213	Same as D1212	
D1222	Same as D1212	
D1226	Same as D1212	
D1231	Same as D1212	
D1233	Same as D1212	
D1235	Same as D1212	
D1240		DDD071701
D1241		DDD070291
D1261	Same as D1212	
D1262	Same as D1212	
D1263	Same as D1212	
D1264	Same as D1212	
D1270	Same as D1212	
D1271	Same as D1212	
D1272	Same as D1212	
D1273	Same as D1212	
D1274	Same as D1212	
D1275	Same as D1212	

CKT. NO.	DESCRIPTION	IWATSU PARTS NO.
D1276	Same as D1212	
D1277	Diode, 1SS16	DDD010411
D1281	Same as D1212	
D1282	Same as D1277	
D1283	Same as D1212	
D1286	Same as D1277	
D1287	Same as D1277	
D1292	Same as D1212	
D1293	Same as D1212	
Q1216	Transistor, 2SC1216	DTR130791
Q1232	Transistor, 2SC373	DTR137781
Q1265	Same as Q1216	
Q1267	Same as Q1216	
IC1201	Integrated circuit, SN7400N	DIC125001
IC1202	Same as IC1201	
IC1203	Same as IC1201	
IC1204	Same as IC1201	
IC1205	Same as IC1201	
IC1206	Integrated circuit, SN74107N	DIC126051
IC1251	Same as IC1206	
IC1252	Integrated circuit, SN7403N	DIC125031
IC1253	Integrated circuit, SN7406N	DIC125061
IC1254	Same as IC1253	
RL1231	Reed Relay, ROP11106	DKD066081
S1201	Push Switch, KSD3-6-10MLDC	DSW013731
S1202	Push Switch, KSD4-8-10ILDC	DSW013332
S1241a.b	Push Switch, KSD2-4-10NLDC	DSW013311
DA1201	Diode Array, DAN4	DDD010441
DA1202	Same as DA1201	
DA1203	Same as DA1201	
DA1204	Same as DA1201	
DA1205	Same as DA1201	
DA1206	Diode Array, DAP4	DDD010311
RA1201	Resistor Array, RM8 10kΩK	DFB015631
RA1202	Resistor Array, RM4 10kΩK	DFB015541
RA1203	Same as RA1202	
RA1255	Resistor Array, RM4 10kΩK	DFB015541

CKT. NO.	DESCRIPTION	IWATSU PARTS NO.
RA1256	Resistor Array, RM41kΩK	DFB015841
RA1257	Same as RA1255	
RA1259	Same as RA1255	
PJ1001	Connector, 129-08-10-281	DCN032371
J703	Connector, 65039-035	DCN033131
J704	Same as J703	
J706	Same as J703	
J1002	Connector, 65039-034	DCN033121
J1011	Connector, U-SA1501	DCN031171
J1022	Same as J1011	
P703	Connector, 65532-X36	DCN033521
P704	Same as P703	
P706	Same as P703	
P1002	Same as P703	
P1003	Connector, 75401-002	DCN033041
P1011	Connector, U-PA1519	DCN031131
P1022	Same as P1011	

HORIZONTAL AMPLIFIER

CKT. NO.	DESCRIPTION	IWATSU PARTS NO.
C1401	Cap., 0.01μ, +80 –20%, 500V, Cer.	DCC153511
C1402	Cap., 10μ, +100 –10%, 63V, Elect.	DCE142511
C1403	Cap., 10μ, ±20%, 35V, Elect. Tan.	DCS471301
C1404	Cap., 0.01μ, +80 –20%, 50V, Cer.	DCC133571
C1405	Same as C1403	
C1406	Same as C1404	
C1412	Same as C1404	
C1413	Same as C1404	
C1414	Same as C1403	
C1416	Same as C1404	
C1433	Same as C1404	
C1438	Same as C1403	
C1441	Same as C1404	
C1444	Same as C1404	
C1445	Same as C1404	
C1457	Same as C1404	
C1460	Same as C1404	
C1461	Same as C1401	
C1463	Cap., 330p, ±5%, 50V, Cer.	DCC234901
C1464	Same as C1404	
C1465	Same as C1404	
C1466	Cap., 0.5 ~1.5p, Var., 500V, Plastic	DCV023121
C1471	Cap., 0.1μ, ±20%, 200V, Plastic	DCF158021
C1481	Cap., 100p, ±10%, 50V, Cer.	DCC239081
C1482	Same as C1404	
C1483	Same as C1466	
C1487	Same as C1401	
C1488	Same as C1471	
C1489	Same as C1404	
L1451	Inductor, Ferrite Bead Core, L82-OP-03-03-1H	DCL320251
L1455	Same as L1451	
L1464	Same as L1451	
L1465	Same as L1451	
L1488	Same as L1451	
L1489	Same as L1451	
R1403	Res., 10, ±5%, 1/4W, Carbon	DRD130351
R1405	Same as R1403	
R1411	Res., 51, ±5%, 1/4W, Carbon	DRD130521
R1412	Res., 10k, ±5%, 1/4W, Carbon	DRD131071

CKT. NO.	DESCRIPTION	IWATSU PARTS NO.
R1413	Res., 3.6k, ±5%, 1/4W, Carbon	DRD130961
R1414	Res., 1.5k, ±5%, 1/4W, Carbon	DRD130871
R1415	Res., 4.3k, ±2%, 1/2W, Metal	DRE143881
R1416	Same as R1415	
R1421	Res., 4.7k, ±5%, 1/4W, Carbon	DRD130991
R1422a.b (S1422)	Res., (10k +10k), Var., 0.125W, Carbon with switch	DRV146272
R1423	Res., 75k, ±5%, 1/4W, Carbon	DRD131281
R1431	Res., 240, ±2%, 1/4W, Metal	DRE133581
R1432	Res., 100, ±20%, 0.5W, Cermet	DRV411021
R1433	Res., 75, ±2%, 1/4W, Metal	DRE133421
R1434	Res., 750, ±2%, 1/4W, Metal	DRE133701
R1435	Res., 10k, ±20%, 0.5W, Cermet	DRV411071
R1436	Res., 2.4k, ±2%, 1/4W, Metal	DRE133781
R1437	Same as R1434	
R1438	Same as R1431	
R1441	Same as R1436	
R1442	Res., 18k, ±2%, 1/4W, Metal	DRE134031
R1443	Res., 200k, ±5%, 1/4W, Carbon	DRD131381
R1444	Res., 43k, ±2%, 1/4W, Metal	DRE134121
R1452	Res., 130, ±2%, 1/4W, Metal	DRE133521
R1453	Res., 1.8k, ±5%, 1/4W, Carbon	DRD130871
R1454	Res., 500, ±20%, 0.5W, Cermet	DRV411041
R1455	Same as R1452	
R1456	Res., 240, ±2%, 1/2W, Metal	DRE143581
R1457	Res., 200, ±20%, 0.5W, Cermet	DRV411031
R1458	Same as R1453	
R1461	Res., 1.3k, ±5%, 1/4W, Carbon	DRD130861
R1462	Res., 130, ±5%, 1/4W, Carbon	DRD130621
R1463	Same as R1462	
R1464	Same as R1461	
R1466	Res., 5.1k, ±2%, 2W, Metal	DRE160121
R1467	Same as R1466	
R1468	Res., 3k, ±2%, 1/4W, Metal	DRE133841
R1469	Res., 75k, ±2%, 1/2W, Metal	DRE144181
R1470	Res., 360, ±2%, 1/4W, Metal	DRE133621
R1471	Res., 12k, ±2%, 2W, Metal	DRS231251
R1472	Res., 24, ±5%, 1/4W, Carbon	DRD130441
R1481	Same as R1462	
R1482	Same as R1461	
R1483	Same as R1466	
R1484	Same as R1466	
R1486	Same as R1468	

CKT. NO.	DESCRIPTION	IWATSU PARTS NO.
R1487	Same as R1469	
R1488	Same as R1470	
R1489	Same as R1471	
R1490	Same as R1472	
D1411	Diode, 1S953	DDD010051
D1438	Z. Diode, RD10E B	DDD030681
Q1431	Transistor, 2N3905	DTR150011
Q1436	Same as Q1431	
Q1441	Same as Q1431	
Q1451	Transistor, 2SC1424	DTR136931
Q1455	Same as Q1451	
Q1461	Same as Q1431	
Q1463	Transistor, 2SC1216	DTR130791
Q1465	Transistor, 2SC1217	740306930
Q1470	Transistor, 2SA712	DTR110571
Q1481	Same as Q1463	
Q1488	Same as Q1470	
Q1489	Same as Q1465	
IC1410	Integrated circuit, B60	DIC820601
RL1433	Reed Relay, ROP11112	DKD061001
S1422	Refer to R1422a b	
J1411	Connector, 65039-035	DCN033131
J1422	Same as J1411	
J1433	Connector, 65039-034	DCN033121
J1455	Connector, 65039-032	DCN033101
P1411	Connector, 65532-X36	DCN033521
P1422	Same as P1411	
P1433	Same as P1411	
P1455	Same as P1411	

CKT. NO.	DESCRIPTION	IWATSU PARTS NO.
Z AXIS AMPLIFIER		
C1513	Cap., 0.047μ, ±10%, 50V, Cer.	DCF120311
C1515	Cap., 0.01μ, +80 –20%, 50V, Cer.	DCC133571
C1521	Cap., 0.01μ, +100 –0%, 500V, Cer.	DCC153511
C1525	Cap., 0.1μ, ±20%, 200V, Plastic	DCF158021
C1531	Same as C1515	
C1532	Same as C1515	
C1535	Cap., 0.5 ~ 1.5p, Var., 500V, Plastic	DCV023121
C1542	Same as C1521	
C1543	Cap., 0.01μ, ±20%, 3K V, Plastic	DCF283131
C1551	Same as C1521	
C1552	Cap., 10μ, ±20%, 35V, Tan. Elect.	DCS471301
C1553	Same as C1552	
C1576	Same as C1521	
L1521	Inductor, Ferrite Bead Core L82-0P-03-03-1H	DCL320251
R1502a b	Res., (10K + 10K), Var., 0.125W, Carbon	DRV146261
R1511	Res., 10, ±5%, 1/4W, Carbon	DRD139211
R1512	Same as R1511	
R1513	Res., 200, ±20%, 0.5W, Cermet	DRV411031
R1514	Res., 750, ±5%, 1/4W, Carbon	DRD139401
R1515	Res., 10K, ±5%, 1/4W, Carbon	DRD139161
R1521	Res., 620, ±5%, 1/4W, Carbon	DRD130781
R1522	Res., 51K, ±5%, 1/4W, Carbon	DRD139721
R1523	Res., 7.5k, ±2%, 1/2W, Metal	DRE143941
R1524	Res., 100k, ±5%, 1/4W, Carbon	DRD139751
R1525	Res., 20k, ±2%, 1W, Metal	DRE154041
R1532	Same as R1514	
R1533	Res., 2.4k, ±5%, 1/4W, Carbon	DRD139471
R1534	Same as R1524	
R1535	Res., 10k, ±2%, 1/2W, Metal	DRE143971
R1536	Same as R1535	
R1541	Res., 300, ±5%, 1/4W, Carbon	DRD138801
R1542	Res., 30k, ±5%, 1/4W, Carbon	DRD139671
R1543	Res., 1M, ±5%, 1/2W, Metal	DRE144451
R1551	Same as R1511	
R1552	Same as R1511	
R1553	Same as R1511	
R1561	Res., 68k, ±5%, 1/4W, Carbon	DRD139731
R1562	Res., 5.1k, ±5%, 1/4W, Carbon	DRD139531
R1563	Res., 1.8k, ±5%, 1/4W, Carbon	DRD139441
R1564	Same as R1515	
R1565	Res., 3.3k, ±5%, 1/4W, Carbon	DRD139501
R1566	Res., 62k, ±5%, 1/4W, Carbon	DRD138811
R1567	Same as R1515	
R1568	Res., 5.1k, ±2%, 1/2W, Metal	DRE143901
R1569	Res., 750, ±2%, 1/2W, Metal	DRE143701
R1571	Same as R1515	
R1572	Res., 4.3k, ±5%, 1/4W, Carbon	DRD139951
R1573	Res., 300k, ±2%, 1/2W, Metal	DRE144321
R1574	Res., 200k, ±5%, 1/4W, Carbon	DRD139791
R1575	Same as R1574	
R1576	Res., 15k, ±5%, 1/4W, Carbon	DRD131111
D1515	Diode, 1S953	DDD10051
D1516	Same as D1515	
D1517	Same as D1515	
D1533	Same as D1515	
D1561	Same as D1515	
D1562	Same as D1515	
D1564	Same as D1515	
D1576	Diode, V 03C	DDD020011
Q1514	Transistor, 2SC1216	DTR130791
Q1521	Transistor, 2N3905	DTR150011
Q1523	Transistor, 2SA810GB	DTR115691
Q1531	Transistor, 2SC373	DTR137611
Q1533	Transistor, 2SC154C	DTR145381
Q1560	Same as Q1531	
Q1572	Transistor, 2SA845A Ⓗ	DTR115741
Q1575	Transistor, 2SC1706 Ⓗ	DTR130981
NL1544	Neon Bracket Lamp, NL235D	DLD025171
W1501	Delay Line, 1.5DXV	528502009
J1501	Connector, 65039-035	DCN033131
J1502	Same as J1501	
J1503	Connector, 65039-033	DCN033111
J1504	Same as J1501	
J1505	BNC Connector, BNC-BR-226	DCN040711

CKT. NO.	DESCRIPTION	IWATSU PARTS NO.
CRT CIRCUIT		
C1612	Cap., 47μ, +100 −10%, 63V, Elect.	DCE142661
C1621	Cap., 0.1μ, ±10%, 50V, Plastic	DCF120351
C1625	Cap., 1000p, ±20%, 3K V, Plastic	DCF283141
C1626	Cap., 0.01μ, ±20%, 3KV, Plastic	DCF283131
C1628	Cap., 0.22μ, ±10%, 50V, Plastic	DCF120391
C1634	Cap., 10μ, +100 −10%, 35V, Elect. Tan.	DCS471301
C1652	Cap., 0.01μ, +100 −0%, 500V, Cer.	DCC153511
C1653	Same as C1652	
C1656	Same as C1652	
C1657	Same as C1652	
C1658	Same as C1652	
C1662	Same as C1652	
C1663	Cap., 0.01μ, +100 −0%, 500V, Cer.	DCC153511
C1664	Cap., 5000p, ±20%, 300V, Plastic	DCF283121
C1665	Same as C1663	
L1671	Inductor, Lotation Coil	DCL140181
L1672	Inductor, Orthogonality Coil	DCL140111
R1601	Res., 1M, ±20%, 0.5W, Cermet	DRV411141
R1612	Res., 510, ±5%, 1/4W, Carbon	DRD130761
R1621	Res., 2k, ±5%, 1/4W, Carbon	DRD139451
R1622	Res., 100k, ±5%, 1/4W, Carbon	DRD139751
R1623	Res., 1k, ±5%, 1/4W, Carbon	DRD139141
R1624	Res., 200k, ±5%, 1/4W, Carbon	DRD131381
R1625	Res., 15M, ±5%, 2W, Metal	DRG163291
R1626	Res., 10k, ±5%, 1/4W, Carbon	DRD131071
R1627	Res., 300k, ±2%, 1/2W, Metal	DRE144321
R1628	Res., 620k, ±2%, 1/2W, Metal	DRE144401
R1629	Res., 50k, ±20%, 0.5W, Cermet	DRV411101
R1631	Res., 30k, ±5%, 1/4W, Carbon	DRD139671
R1632	Res., 5.1k, ±5%, 1/4W, Carbon	DRD139531
R1633	Res., 82k, ±5%, 1/4W, Carbon	DRD139741
R1634	Same as R1631	
R1635	Res., 1M, ±2%, 1/2W, Carbon	DRE144451
R1636	Res., 4.7k, ±5%, 1/4W, Carbon	DRD139151
R1637	Res., 1k, ±20%, 0.5W, Cermet	DRV411051
R1638	Res., 1.8k, ±5%, 1/4W, Carbon	DRD139441
R1639	Same as R1635	
R1640	Res., 16k, ±5%, 1/4W, Carbon	DRD139621
R1651	Res., 51k, ±2%, 1/4W, Metal	DRE134141

CKT. NO.	DESCRIPTION	IWATSU PARTS NO.
R1652	Res., 100k, ±2%, 1/4W, Metal	DRE939191
R1653	Res., 200k, Var., 0.5W, Cermet	DRV420241
R1654	Same as R1653	
R1655	Same as R1652	
R1656	Res., 180k, ±2%, 1/2W, Metal	DRE144271
R1657	Res., 200k, ±2%, 1/2W, Metal	742219152
R1658	Res., 500k, Var., 0.5W, Cermet	743493129
R1659	Same as R1658	
R1660	Same as R1657	
R1661	Res., 510k, ±2%, 1/2W, Metal	DRE144271
R1662	Res., 200k, Var., 0.5W, Cermet	DRV420241
R1664	Res., 100k, ±2% 1/4W, Metal	DRE134211
R1671	Res., 5k, Var., 0.75W, W.W	DRV630191
R1672	Res., 1k, ±5%, 1/4W, Carbon	DRD139141
R1673	Same as R1671	
R1674	Res., 510, ±5%, 1/4W, Carbon	DRD139381
D1611	Diode, 1S953	DDD010051
D1612	Same as D1611	
D1613	Same as D1611	
D1621	Same as D1611	
D1632	Same as D1611	
Q1611	Transistor, 2SC1669-O	DTR130951
Q1631	Transistor, 2SC373	DTR137781
IC1621	Integrated circuit, μPC251C	DIC610091
V1611	Cathode Ray Tube, S-8213 B31	DET016121
PJ1600	Connector, 128-08-10-281	DCN032341
PJ1651	Connector, 129-12-10-281	DCN033521
J1620	Connector, 65039-035	DCN033131
J1671	Same as J1620	
J1672	Same as J1620	
P1671	Connector, 65532-X36	DCN033521
P1672	Same as P1671	
U1600	High Voltage Unit, HVU-4CA2001	DES050182

CKT. NO.	DESCRIPTION	IWATSU PARTS NO.
POWER SUPPLY		
C1811	Cap., 10μ, +100 −10%, 250V, Elect.	DCE170501
C1818	Cap., 33μ, +100 −10%, 50V, Elect.	DCE140601
C1819	Cap., 100μ, +100 −10%, 160V, Elect.	DCE260751
C1820	Cap., 4.7μ, +100 −10%, 250V, Elect.	DCE170401
C1832	Cap., 0.1μ, ±10%, 50V, Poly.	DCF120351
C1833	Cap., 0.01μ, +80 −20%, 50V. Cer.	DCC133571
C1841	Cap., 1000μ, +100 −10%, 63V, Elect.	DCF443011
C1843	Cap., 10μ, +100 −10%, 35V, Elect. Tan.	DCS461301
C1844	Same as C1843	
C1847	Cap., 22μ, +100 −10%, 63V, Elect.	DCE242561
C1851	Cap., 4700μ, +100 −10%, 25V, Elect.	DCE925141
C1853	Same as C1833	
C1857	Cap., 47μ, +100 −10%, 35V, Elect.	DCE230651
C1865	Cap., 22μ, +100 −10%, 25V, Elect.	DCE222551
C1871	Cap., 4700μ, +100 −10%, 25V, Elect.	DCE423151
C1873	Same as C1833	
C1876	Same as C1843	
C1878	Same as C1865	
R1812	Res., 10, ±2%, 1/4W, Metal	DRE133251
R1813	Res., 150k, ±2%, 1/2W, Metal	DRE144251
R1814	Res., 200, ±5%, 1/4W, Carbon	DRD139311
R1815	Res., 150k, ±2%, 1/2W, Metal	DRE144251
R1816	Res., 12k, ±2%, 1/4W, Metal	DRE133991
R1817	Res., 11k, ±5%, 1/4W, Carbon	DRD138951
R1818	Res., 20k, ±5%, 1/4W, Carbon	742232170
R1819	Res., 200k, ±2%, 1/2W, Metal	DRE144281
R1830	Res., 3.3k, ±5%, 1/4W, Carbon	DRD130951
R1832	Res., 50, Var., W.W.	DRV350142
R1833	Res., 7.5k, ±5%, 1/4W, Carbon	DRD139571
R1834	Res., 47k, ±5%, 1/4W, Carbon	DRD139171
R1841	Res., 100k, ±5%, 1/4W, Carbon	DRD139751
R1842	Res., 24k, ±5%, 1W, Metal	DRS221891
R1845	Res., 1, ±5%, 1W, Metal	DRS221791
R1846	Res., 10k, ±5%, 1/4W, Carbon	DRD139161
R1847	Res., 40k, ±0.5%, 1/4W, Metal	DRE233791
R1848	Res., 12k, ±0.5%, 1/4W, Metal	DRE233621
R1851	Same as R1818	
R1852	Res., 30k, ±5%, 1/4W, Carbon	DRD139671
R1855	Res., 0.3, ±5%, 1W, Metal	DRS221831
R1856	Res., 6.8k, ±5%, 1/4W, Carbon	DRD131031

CKT. NO.	DESCRIPTION	IWATSU PARTS NO.
R1857	Same as R1848	
R1858	Same as R1848	
R1861	Same as R1818	
R1862	Res., 0.91, ±5%, 1W, Metal	DRS221851
R1863	Same as R1856	
R1864	Res., 10k, ±2%, 1/4W, Metal	DRE939301
R1865	Res., 24k, ±2%, 1/4W, Metal	DRE134061
R1871	Same as R1818	
R1872	Res., 1.5k, ±5%, 1/4W, Carbon	DRD139431
R1873	Same as R1814	
R1875	Same as R1855	
R1876	Res., 390, ±2%, 1/4W, Metal	DRE133631
R1877	Res., 5.6k, ±2%, 1/4w, Metal	DRE133911
R1878	Res., 1k, ±20%, 0.5W, Cermet	DRV411051
R1879	Res., 2.2k, ±2%, 1/4W, Metal	DRE939021
R1880	Res., 1.8k, ±2%, 1/4W, Metal	DRE939171
D1811	Diode, V 03C	DDD020011
D1815	Diode, 1S953	DDD010051
D1816	Z. Diode, RD75E	DDD030231
D1817	Same as D1816	
D1818	Same as D1811	
D1819	Diode, 2B8DM	DDD020201
D1820	Same as D1811	
D1830	L.E. Diode, TLR104	DDD070301
D1841	Diode, 2B4DM	DDD020161
D1843	Z. Diode, RD20E	DDD030111
D1844	Same as D1843	
D1845	Same as D1815	
D1846	Same as D1815	
D1847	Same as D1811	
D1851	Same as D1841	
D1853	Z. Diode, RD10E	DDD032251
D1856	Same as D1815	
D1857	Same as D1811	
D1861	Same as D1841	
D1863	Same as D1815	
D1865	Same as D1811	
D1871	Same as D1841	
D1873	Same as D1815	
D1876	Z. Diode, 1S2191	DDD031851
D1878	Same as D1811	

CKT. NO.	DESCRIPTION	IWATSU PARTS NO.
Q1813	Transistor, 2SC373	DTR137781
Q1818	Transistor, 2SC1669-0	DTR130951
Q1842	Same as Q1818	
Q1843	Same as Q1813	
Q1852	Transistor, 2SD560	DTR140231
Q1853	Same as Q1813	
Q1861	Transistor, 2SD288K	DTR145431
Q1862	Same as Q1813	
Q1872	Same as Q1861	
Q1873	Same as Q1813	
Q1874	Same as Q1813	
IC1816	Integrated circuit, μPC151C	DIC610021
IC1840	Integrated circuit, μPC451C	DIC610101
PL1831	Scale Illumination Lamp	DLP016092
PL1832	Same as PL1831	
F1835	Fuse (Slow Blow), FSA-2	745400330
F1836	Thermal Fuse	KAS037311
F1840	Fuse, FSA-1	DFU020141
S1836	Toggle Switch, MTA206A	DSW065371
T1800	Power Transformer	DCL211732
M1871	Fan Motor, PF-60-02	DMT620132
TB1	Ground Terminal, 8φB	DTA020501
PJ1800	Connector, 129-15-10-281	DCN032431
PJ1801	Connector, 129-12-10-281	DCN032411
PJ1805	Same as PJ1800	
J1802	Connector 65039-035	DCN033131
J1803	Same as J1802	
J1804	Same as J1802	
J1835	Connector, Plug X-I 7213	DFV020151
P1835	Connector, Socket S-I 7220	DCN013311

CKT. NO.	DESCRIPTION	IWATSU PARTS NO.
CALIBLATOR		
C1701	Cap., 47μ, +100 −10%, 25V, Elect.	DCE122651
C1702	Cap., 0.01μ, +80 −20%, 50V, Cer.	DCC133571
C1703	Cap., 10μ, +100 −10%, 35V, Elect. Tan.	DCS471301
C1704	Same as C1702	
C1713	Cap., 1000p, ±5%, 100V, Mica	DCM244721
R1701	Res., 10, ±5%, 1/4W, Carbon	DRD139211
R1703	Same as R1701	
R1711	Res., 10k, ±2%, 1/4W, Metal	DRE939301
R1712	Res., 390, ±2%, 1/4W, Metal	DRE133631
R1713	Res., 6.8k, ±2%, 1/4W, Metal	DRE939331
R1714	Same as R1711	
R1715	Res., 330k, ±2%, 1/2W, Metal	DRE144331
R1716	Res., 50k, ±20%, 0.5W, Cermet	DRV420221
R1720	Res., 10k, ±5%, 1/4W, Carbon	DRD139161
R1721	Same as R1720	
R1722	Same as R1720	
R1723	Res., 1k, ±5%, 1/4W, Carbon	DRD139141
R1724	Res., 20k, ±5%, 1/4W, Carbon	DRD138981
R1725	Res., 2.4k, ±5%, 1/4W, Carbon	DRD139471
R1726	Res., 5.1k, ±5%, 1/4W, Carbon	DRD139531
R1727	Res., 1k, Var., 0.5W, Cermet	DRV411051
R1728	Res., 5.2k, ±0.5%, 1/4W, Metal	
R1729	Res., 27k, ±5%, 1/4W, Carbon	DRD139661
R1730	Res., 300, ±0.5%, 1/4W, Metal	DRE234071
R1731	Res., 2.2k, ±0.5%, 1/4W, Metal	DRE233411
Q1722	Transistor, 2SC373	DTR137781
Q1723	Same as Q1722	
Q1727	Transistor, 2N3905	DTR150011
IC1713	Integrated circuit, μPC251C	DIC613571
W1730	Delay Line, 1.5DXV	528502009
TP1730	Test Point	KDS005521
J1701	Connector, 65039-035	DCN033131
TB2	Ground Terminal, 8φB	DTA020501

CKT. NO.	DESCRIPTION	IWATSU PARTS NO.	CKT. NO.	DESCRIPTION	IWATSU PARTS NO.
PRINTED CIRCUIT BOARD			PB700	Sweep Generator	KPN209521
			PB1000	Timing Switch	KPN047171
PB100	Preamplifier	KPN210611	PB1200	Enhance	KPN047311
PB200	CH3 Attennator	KPN047221	PB1350	Vertical Main Amplifier	KPN047431
PB212,311	Strip Line	KPN047711	PB1400	Horizontal Amplifier	KPN047511
PB550	Switching Logic	KPN046891	PB1600	HV Connect	KPN047831
PB600	Trigger Generator	KPN046981	PB1800	Power Supply	KPN047681

SECTION 9
MECHANICAL PARTS LIST AND ILLUSTRATION

FIG. & INDEX NO.	NAME & DESCRIPTION	Q'TY	IWATSU PART NO.
9 - 1 - 1	COVER, upper	1	760318801
- 2	HANDLE, carring	1	760319201
- 3	HANDLE	1	761303201
- 4	NAME PLATE, handle	1	755067302
- 5	SCREW, handle	2	764129002
- 6	COVER, handle lach, right	1	761304601
- 7	COVER, handle lach, left	1	761304701
- 8	INDEX, handle	2	768600601
- 9	NUT	2	760171301
-10	RIVET, plastic	5	771609101
-11	COVER, lower	1	760318901
-12	FOOT, rubber	4	752300101
-13	RIVET	4	756834101
-14	COVER, rear	1	758345301
-15	HOOK, cable	4	761302205
-16	CABLE ASSEMBLY, power	1	744701710
-17	PANEL (1), front	1	758426201
-18	PANEL (2), front	1	758345201
-19	FILTER	1	753066701
-20	BEZEL	1	761401702
-21	PAPER	1	751040001
-22	NAME PLATE, title	1	755067401
-23	KNOB (include set screws), 151330SB	3	754015101
-24	KNOB (include set screws), 151332SB	1	754015201
-25	KNOB (include set screws)	2	754309801
-26	KNOB (include set screws) 101316DR	2	754011602
-27	FRAM, push button	1	761021402
-28	KNOB (include set screws), 161660DSB	3	754308301
-29	KNOB (include set screws), 101330DR	2	754011102
-30	FRAME, push button	25	761020402
-31	KNOB (include set screws), 121330DRP	1	754015401
-32	KNOB (include set screws), 151330SBP	2	754015801
-33	KNOB (include set screws)	1	743410220
-34	KNOB (include set screws), 131230DR	1	754008101
-35	KNOB (include set screws), 261947DSB	1	754309301
-36	KNOB (include set screws), 441571TB	1	754309201
-37	TIMING PANEL COVER	1	750011901
-38	TIMING PANEL	1	758024501
-39	HOLDER	1	761022104
-40	COVER, panel	1	761401802

FIG. & INFEX NO.	NAME & DESCRIPTION	Q'TY	IWATSU PART NO.
-41	SCREW, thd forming, truss, 3 x 10mm	4	756814601
-42	SCREW, PHS, 3 x 8 mm	3	756802601
-43	SCREW, PHS, 4 x 22 mm	4	756805201
-44	SCREW, thd forming, truss, 3 x 8 mm	12	756814501
-45	SCREW, tapping, thd forming, 2 x 6 mm	2	756833701
-46	WASHER, lock, 3 mm	3	756820401
-47	WASHER, lock, 4 mm	6	756820501
-48	WASHER, nylon, 3 mm	12	756828601
-49	WASHER, flat, 3 mm	3	756819601

Fig. 9-1

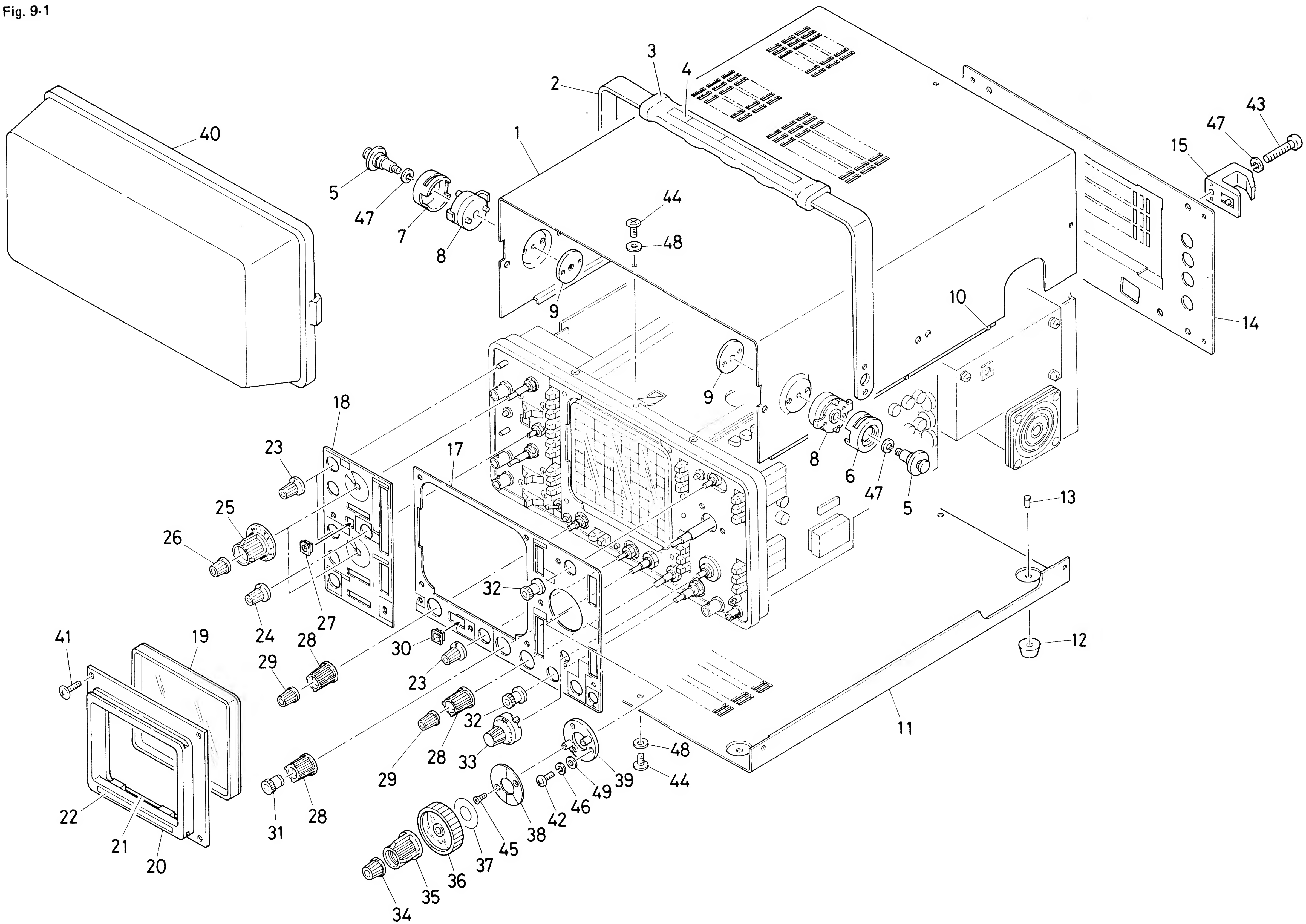

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FIG. & INDEX NO.	NAME & DESCRIPTION	Q'TY	IWATSU PART NO.
9-2- 1	SUB PANEL (1), front	1	758426201
- 2	SUB PANEL (2), front	1	758345201
- 3	DIODE, light emission	2	740405229
- 4	BUSHING	2	761004703
- 5	CONNECTOR, BNC	8	745002530
- 6	POTENTIOMETER	1	743210250
- 7	POTENTIOMETER	1	743222989
- 8	POTENTIOMETER	1	743222860
- 9	STAY, power switch	1	760019201
-10	SWITCH, toggle	1	744301639
-11	DIODE, light emission	1	740405359
-12	POTENTIOMETER	1	743310480
-13	POTENTIOMETER	1	743222987
-14	POTENTIOMETER	1	743222988
-15	TERMINAL, CAL	1	771004601
-16	TERMINAL, GND	1	745100320
-17	POTENTIOMETER	1	743410480
-18	HOLDER, lamp	1	760019302
-19	HOLDER, lamp	2	750006801
-20	LAMP, illumination	2	744900150
-21	ILLUMINATION PLATE, lamp	1	763090001
-22	PUSH BUTTON	2	754012902
-23	PRINTED CIRCUIT BOARD enhance	1	744153201
-24	CHASSIS	1	760509507
-25	GROMMET, plastic	1	763616601
-26	GROMMET	1	752004201
-27	INSULATE BUSHING	4	763064601
-28	TRANSFORMER	1	744713057
-29	INSULATE PACKING	4	751602201
-30	PANEL, rear	1	758024601
-31	TRANSISTOR	1	740308475
-32	TRANSISTOR	2	740308478
-33	TRANSISTOR	3	740308427
-34	BUSHING	6	761603301
-35	INSULATE PLATE	6	750603301
-36	HOLDER, fuse	1	744800950
-37	GROMMET	4	756605001
-38	HOLDER, cable	1	764134401
-39	NUT, holder	1	764134501
-40	LOCK RING, holder	1	764651001
-41	TERMINAL	1	771004501
-42	STAY (B), fan	1	760018702
-43	PLUG, line voltage selector	1	745005830
-44	SOCKET, line voltage selector	1	744802270
-45	RECTIFIER BLOCK	1	744703949
-46	SUPPORTER, bolt	3	764133801
-47	PRINTED CIRCUIT BOARD HV connect	1	744153702
-48	CASE, high voltage	1	760018501
-49	FRAME, push button	1	761021401
-50	GROMMET, plastic	2	763616301
-51	STAY (A), fan	1	760018601
-52	FAN	1	745500310
-53	SPACER, fan	2	760192101
-54	SCREW, phs, 3 x 6 mm	1	756802501
-55	SCREW, phs, 3 x 8 mm	16	756802601
-56	SCREW, phs, 4 x 12 mm	2	756804901
-57	SCREW, thd forming, CSK, FHS, 2.6 x 6 mm	1	756807201
-58	SCREW, thd forming, CSK, FHS, 2.6 x 8 mm	2	756807301
-59	SCREW, thd forming, CSK, FHS, 3 x 6 mm	3	756808101
-60	SCREW, thd forming, CSK, FHS, 3 x 8 mm	5	756808201
-61	SCREW, thd forming, CSK, FHS, 3 x 12 mm	6	756808401
-62	SCREW, thd forming, CSK, FHS, 3 x 14 mm	1	756808501
-63	SCREW, thd forming, CSK, FHS, 3 x 16 mm	3	756808601
-64	WASHER, lock, 2.6 mm	2	756820301
-65	WASHER, lock, 3 mm	25	756820401
-66	WASHER, lock, 4 mm	4	756820501
-67	WASHER, flat, 3 mm	18	756819601
-68	WASHER, flat, 4 mm	6	756819701
-69	NUT, 2.6 mm	2	756818601
-70	NUT, 3 mm	8	756818701
-71	NUT, 4 mm	4	756818801
-72	TERMINAL, 10.2ϕ	8	760603902

Fig. 9-2

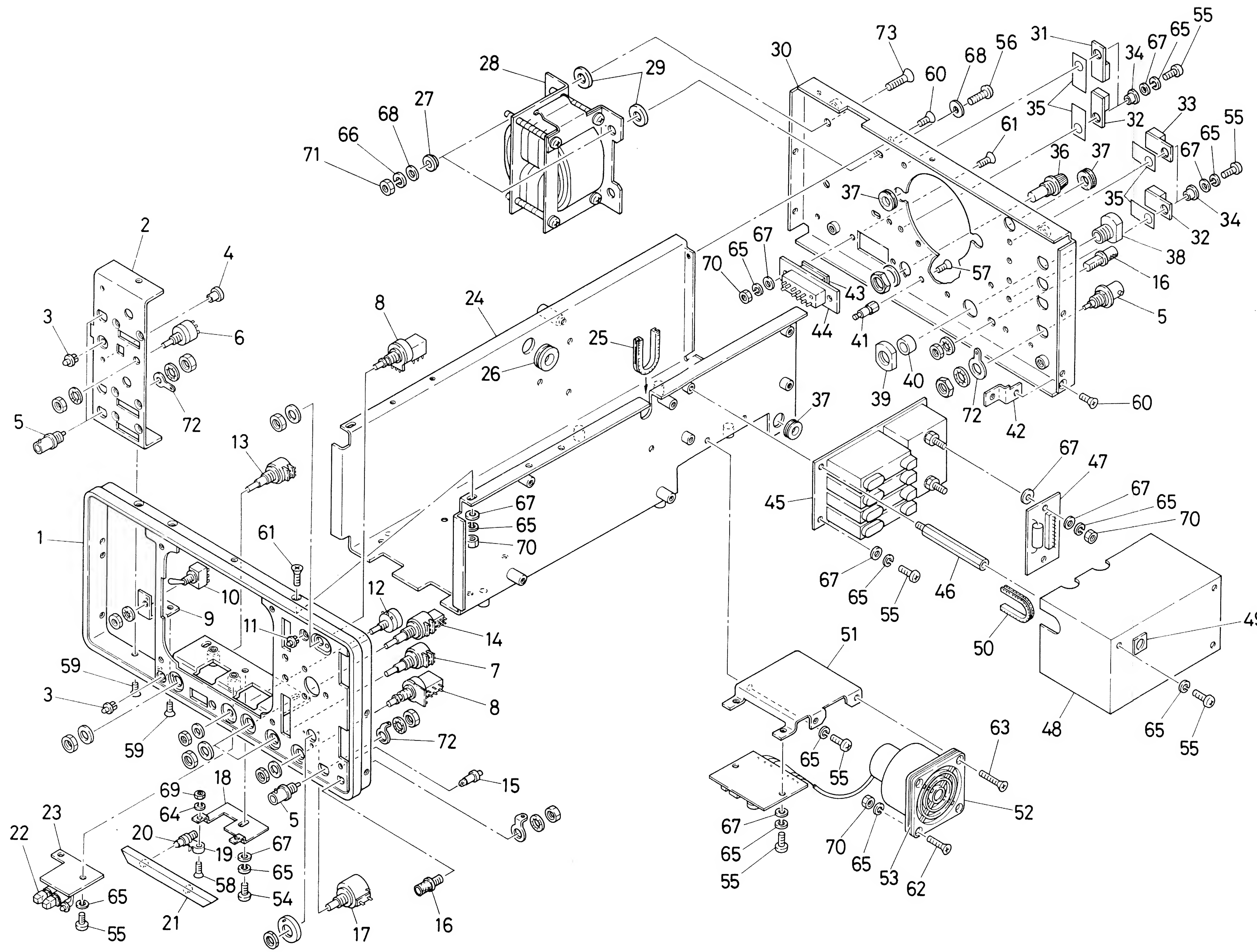
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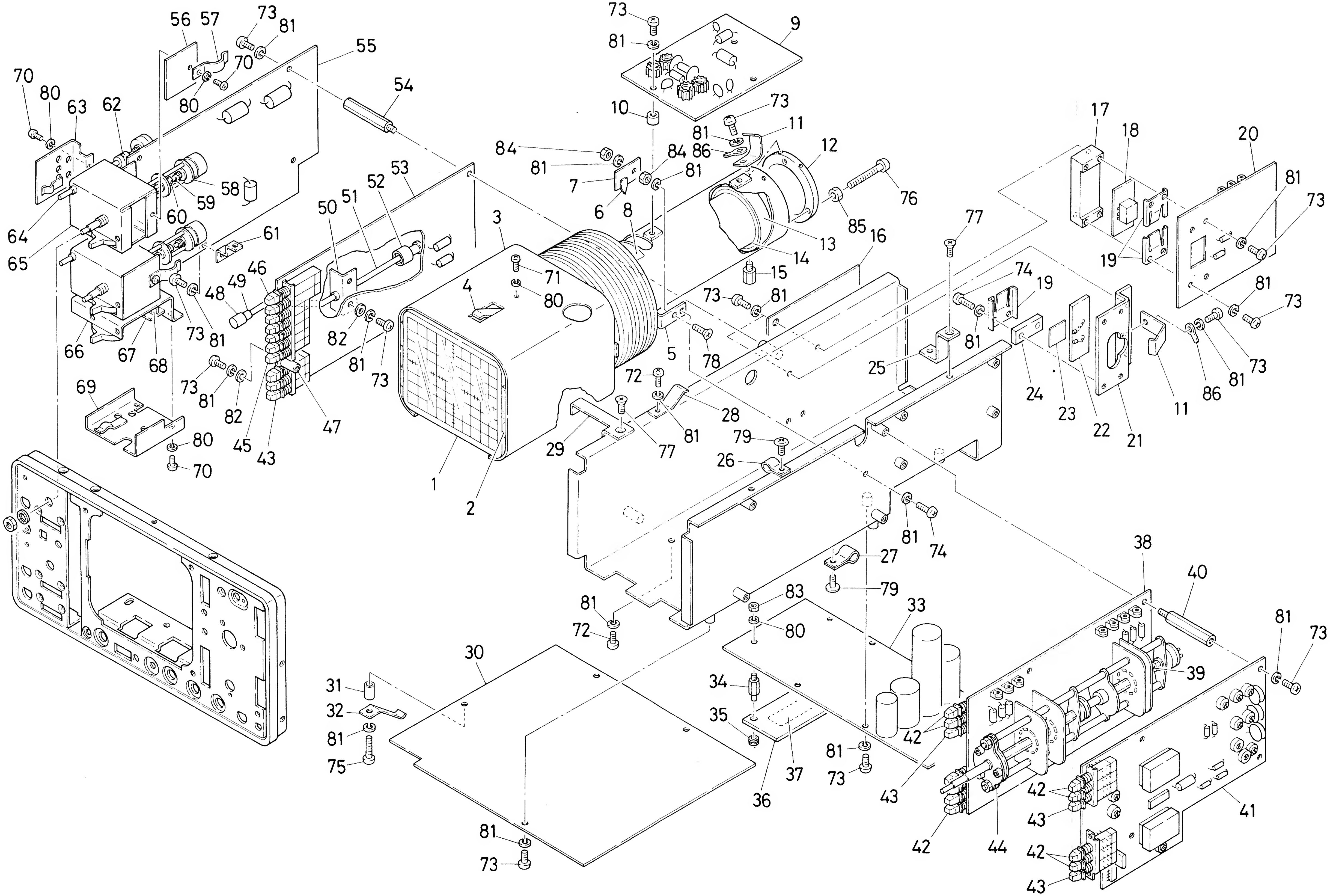
FIG. & INDEX NO.	NAME & DESCRIPTION	Q'TY	IWATSU PART NO.
9 - 3 - 1	CATHODE-RAY TUBE (CRT)	1	740101527
- 2	CUSHION, CRT	3	751016004
- 3	SHIELD CASE, CRT	1	757502603
- 4	SPRING PLATE	1	760145402
- 5	HOLDER, cable	1	760319103
- 6	PLATE, GND	2	760020601
- 7	PRINTED CIRCUIT BOARD strip line	2	744153503
- 8	LABEL	1	755014301
- 9	PRINTED CIRCUIT BOARD, horizontal amplifier	1	744153401
-10	SPACER	2	763208601
-11	SPRING PLATE	2	760022101
-12	RING, CRT, rear	1	764078101
-13	HOLDER, CRT	1	760036602
-14	CUSHION, CRT	1	752600902
-15	SUPPORTER, bolt	1	764133901
-16	SHIELD PLATE, power supply	1	760022301
-17	HEAT SINK, IC	1	764133501
-18	INTERGRATED CIRCUIT	1	745700839
-19	HOLDER, IC	4	760020301
-20	PRINTED CIRCUIT BOARD, vertical main amplifier	1	744153303
-21	HOLDER, termination resistor	1	760019401
-22	TERMINATION RESISTOR	1	745700838
-23	PLATE, termination resistor	2	760022201
-24	SPACER	2	760019501
-25	STAY, printed circuit board	1	760018902
-26	BAND, vinyle	1	750000101
-27	BAND, vinyle	1	750000609
-28	SPRING PLATE	4	760020501
-29	STAY, printed circuit board	1	760018801
-30	PRINTED CIRCUIT BOARD, sweep generator	1	744152404
-31	SPACER	1	764643801
-32	SPRING PLATE	1	760176701
-33	PRINTED CIRCUIT BOARD, power supply	1	744153503
-34	SUPPORTER, insulate bolt	2	761022204
-35	GROMMET	2	752009501
-36	PLATE	1	763090201
-37	LABEL, danger	1	755059101
-38	PRINTED CIRCUIT BOARD, timing switch	1	744152501
-39	COUPLING COIL	1	767008701
-40	SUPPORTER, bolt	4	764133602
-41	PRINTED CIRCUIT BOARD, trigger generator	1	744152303

FIG. & INDEX NO.	NAME & DESCRIPTION	Q'TY	IWATSU PART NO.
-42	PUSH BUTTON, light blue	10	754012802
-43	PUSH BUTTON, dark gray	6	754014802
-44	ROTARY SWITCH	1	744317048
-45	PUSH BUTTON, slate gray	2	754012902
-46	PUSH BUTTON, green	5	754012702
-47	SPACER	1	764651501
-48	PUSH BUTTON	1	761023401
-49	BUSHING	1	761017903
-50	GUIDE PLATE, rod	1	760022401
-51	ROD	1	764134201
-52	INSULATE COUPLING (includes set screws)	1	761017807
-53	PRINTED CIRCUIT BOARD, switching logic	1	744152203
-54	SUPPORTER, bolt	2	764133701
-55	PRINTED CIRCUIT BOARD, preamplifier	1	744152103
-56	COVER	2	760019901
-57	SPRING, GND, attenuator	2	760020402
-58	ROTARY SWITCH	2	744317049
-59	COUPLING COIL	2	767008401
-60	SPACER	2	764124703
-61	STAY, GND	1	760019001
-62	INSULATE COUPLING (includes set screws)	2	750609801
-63	SHIELD PLATE (B), attenuator	2	760019701
-64	ROD	2	763090103
-65	SHIELD PLATE (A), attenuator	2	760019601
-66	SHIELD PLATE (D), attenuator	1	760020001
-67	PRINTED CIRCUIT BOARD, CH3 attenuator	1	744153102
-68	SUPPORTER, bolt	2	764134001
-69	SHIELD PLATE (E), attenuator	1	760020101
-70	SCREW, PHS, 2.6 x 4 mm	5	756801201
-71	SCREW, PHS, 2.6 x 6 mm	1	756801301
-72	SCREW, PHS, 3 x 6 mm	6	756802501
-73	SCREW, PHS, 3 x 8 mm	32	756802601
-74	SCREW, PHS, 3 x 10 mm	4	756802701
-75	SCREW, PHS, 3 x 18 mm	1	756803101
-76	SCREW, full thread, 4 x 25 mm	3	756834801
-77	SCREW, thd forming, CSK, FHS, 3 x 8 mm	4	756808201
-78	SCREW, thd forming, CSK, FHS, 3 x 12 mm	2	756808401
-79	SCREW, thd forming, truss, 3 x 8 mm	2	756814501
-80	WASHER, lock, 2.6 mm	8	756820301

FIG. & INDEX NO.	NAME & DESCRIPTION	Q'TY	IWATSU PART NO.
-81	WASHER, lock, 3 mm	46	756820401
-82	WASHER, flat, 3 mm	3	756819601
-83	NUT, 2.6 mm	2	756818601
-84	NUT, 3 mm	4	756818701
-85	NUT, 4 mm	3	756818801
-86	TERMINAL, 3ϕ	2	766001201

Fig. 9-3



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